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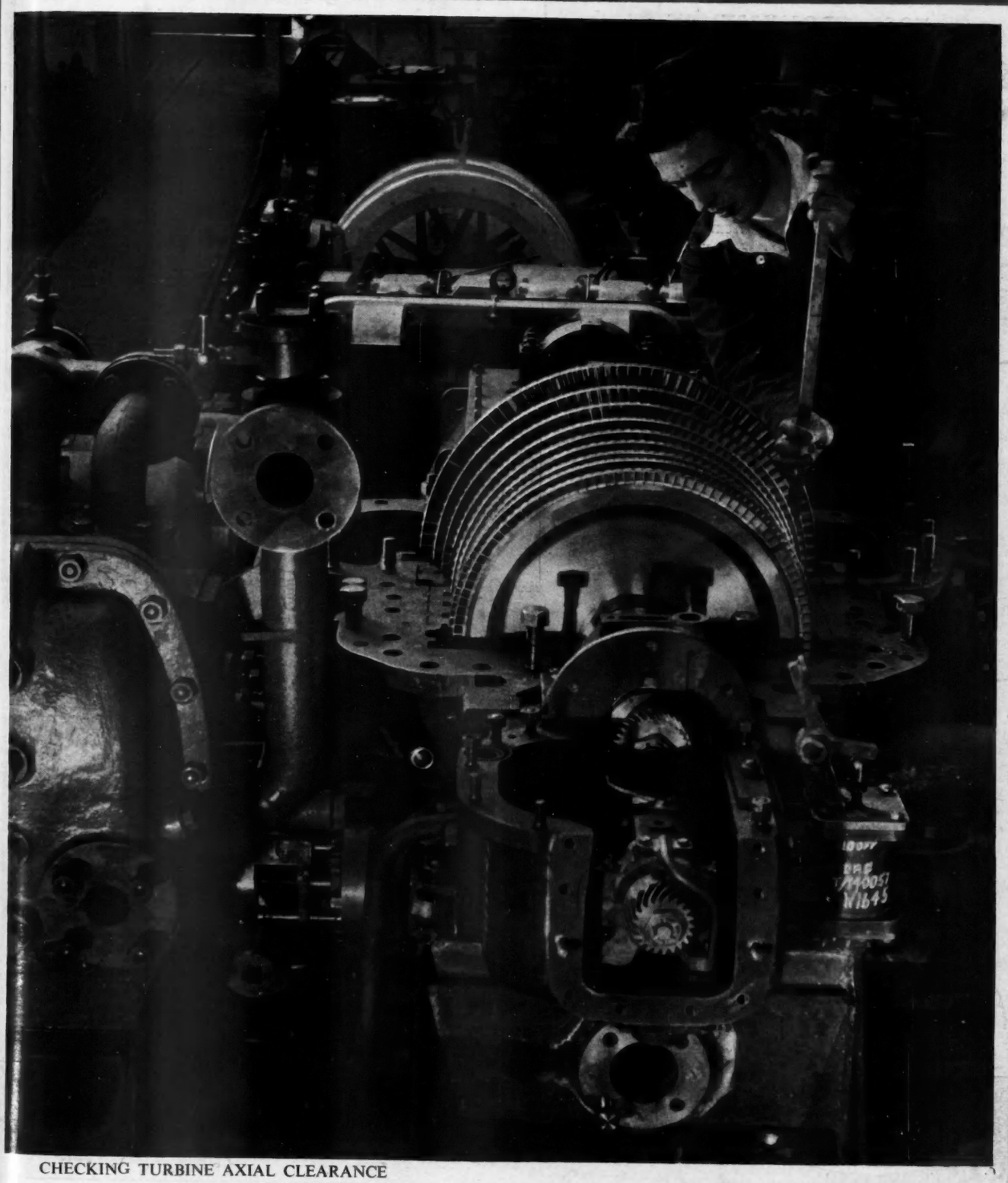

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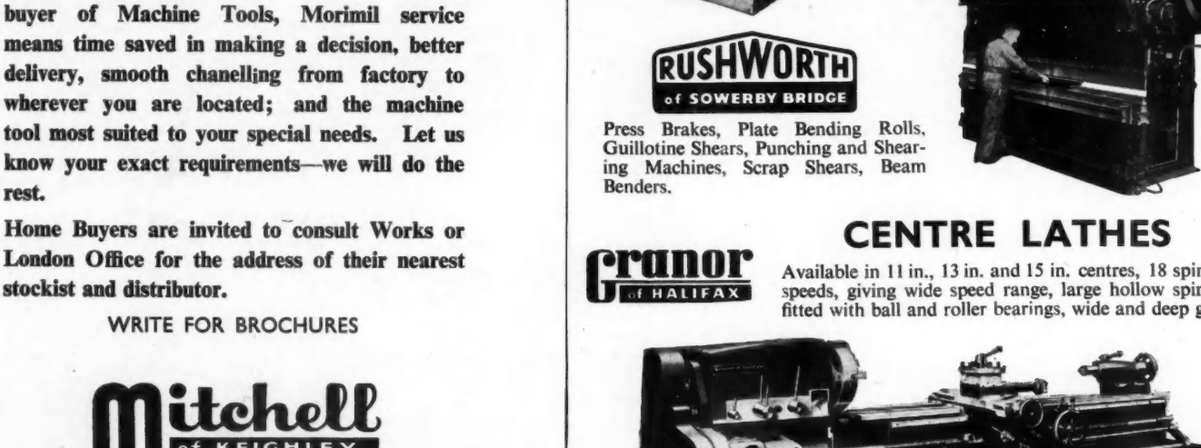

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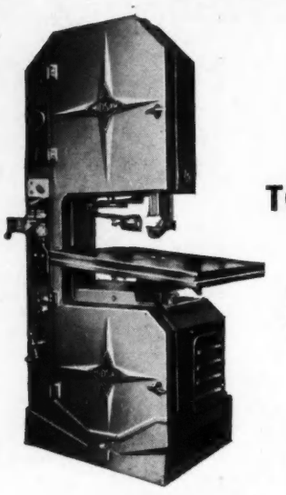

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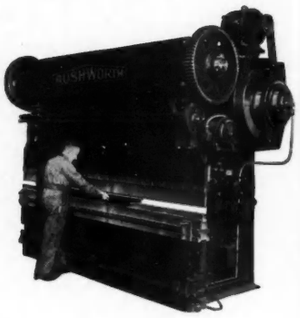

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TWO MANIFESTOS

IT is not the fault of either of Britain's two main political parties that their election manifestos contain nothing that is specially attractive to the majority of voters. With employment still full ten years after VE day and with most people enjoying a reasonable share of the national wealth, there can be no clarion call in the coming General Election. Each party, of course, will be out to stimulate issues that appear to favour their approach to the problems of government. But this artificial heightening of issues during the next few weeks will not blind thinking people to the realisation that, for a complex and changing industrial society, this country looks to a continuing balance of prosperity rather than another bloodless revolution.

The Labour Party drew much of its strength between the wars from the misery of unemployment. Not only the unemployed, but many public-spirited men and women looked hopefully to a party which would forge the instruments of social welfare, giving to those in need and taking from those with abundance. Those political ideals burned brightly again immediately after the war, when thoughts of a new life filled men's minds. The Socialist experiment matched the mood. Wealth has been redistributed on a revolutionary scale—a process actually started before the Labour Party came to power—and the stage has been reached where scope for further redistribution is negligible. There are cases of hardship among all levels of society, but among the employed population there is no valid cause for discontent. In the absence of solid ground for protest or militant action, the trade unions seek opportunities to continue in their traditional rôle by arguing over differentials in wages. It is, in fact, the clearest possible indication of present prosperity that labour troubles arise not from some deep-seated malady like unemployment but from marginal differences in rewards. If the trade unions persist in making further sectional claims they will run the risk of encouraging similar agitation from an unexpected quarter: some of the lower scales of salaries of professional men—men who have studied and worked hard and denied themselves during the early years of their working lives—would not stand up to a just comparison with other representative salaries and wages. For the time being, therefore, there cannot be much outlet in home affairs for that missionary zeal which sprang from an altruistic desire to see justice done.

The Conservative Party has an intangible asset in the respect that most people retain for those who by nature and experience are clearly fitted to lead. The Labour Party has produced its leaders, but those who started as rebels against the established order tend to overshadow their "missionary" colleagues. Thus it is unlikely that the Labour Party permits its best potential leaders to rise as effectively as does the Conservative Party.

If there is one industry that can be said to dominate the political and commercial scene it is the engineeering industry. More people work in it than in any other. The standard of living depends on it more than on any other. It is the biggest exporter. It is indispensible to defence. The welfare of the industry is, then, practically synonymous with the welfare of the country. The Conservative manifesto, *United for Peace and Progress*, has more to say, directly and indirectly, on engineering than its counterpart, *Forward with Labour*. In general terms, the Conservatives state their belief that "as long as we conduct our affairs wisely and get on with the job of raising the national product year by year, the country can be twice as well off in twenty-five years time as it is now." Investment in productive forms of capital is emphasised—factory and farm buildings, plant and machinery, communications and power—and "this must be matched by far-sighted educational policies to augment our scientific and technical skills." A specific reference to a matter of some importance occurs in a section on science and invention: "We regard the widest possible spread of scientific information as a major factor in modern progress. With this in mind we shall take early steps to expand the Patent Office Library into a National Reference Library of Science and Invention, and to develop a National Lending Library of Science and Technology whose facilities will be available to all British firms, large and small." The most significant part of the Labour document, from the engineering point of view, reads: "Public ownership of the steel and road haulage industries is essential to the nation's needs and we shall renationalise them. We shall bring sections of the chemical and machine tools industries into public ownership. Where necessary we shall start new public enterprises."

In one vital subject both Conservative and Labour rise above the ordinary dictates of party politics. The Labour Party refers to "the most profound challenge of our time—the gap between the highly developed industrial nations of the west and the peasant millions of Asia and Africa." The Conservative Party, too, accepts the challenge, and rightly refers to the British Commonwealth and Empire as "the greatest force for peace and progress in the world today." Whichever party is returned to power, it must so strenghthen the British people, morally and commercially, that they can afford to put these ideals into practice.

Weekly Survey

Cover Picture. *Fine running clearances and accurate setting of the rotor in relation to the casing are essential for achieving good steam economy in steam turbines. The cover picture shows a craftsman checking the axial position of the rotor using a feeler gauge. When the rotor is set in the desired position, the adjustment rings in the thrust block bearing are machined to thicknesses which will ensure that the rotor will occupy this position in service.*

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TEXTILE MACHINERY

British output of textile machinery has fallen by about 11 per cent. from the peak of £78 million in 1952. In some sections, notably hosiery, knitting, and jute machinery, production has continued to rise, but the course of demand for machinery for the spinning, twisting and preparatory processes of cotton and wool has been less satisfactory. Fortunately, the downward trend has now been arrested. Textile Machinery Makers, Limited, have maintained a trading profit of £1·6 million in the past few years, and according to the recent report of the directors, the volume of home orders placed in 1954 was a record. Export business, due partly to German and Japanese competition, has been difficult, but large Russian orders have been booked and T.M.M. directors are able to report that the total volume of work on hand for export has expanded. There have been some difficulties over Russian contracts for several types of British equipment, including textile machinery, placed in 1954. It is now reported, however, that these have been definitely settled so far as the order for textile machinery valued at £7 million is concerned, and this gives ground for hope that trouble over orders valued at several million pounds for machine tools and Diesel generators will also be resolved.

T.M.M.'s outlay on research and development is considerable, and T.M.M. (Research) Limited of Helmshore, which was set up shortly after the war, is extending its facilities; these extensions will be complete in 1955 and " will provide the Group with incomparably the finest research facilities in the industry." This does not mean, of course, that the research facilities of such organisations as the British Cotton Industry Research and the Wool Industries Research Association, both of which have played a very large part in evolving improved types of British textile machinery, are inconsiderable. T.M.M. are meeting the need for raising production efficiency by large-scale reorganisation. A major rebuilding scheme at the Hartford works of Platt Brothers and Company will cost £750,000, and the building of a mechanised iron foundry at the Trafford Park Works of Platts (Barton) Limited will also cost £750,000. The first castings will be obtained this summer, little more than twelve months since work began on the site.

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COPPER PRICE-FIXING

The justification of the free market is that in the longer run it should enable consumers to obtain supplies at lower prices than under other arrangements. Admittedly, short-term fluctuations have always been a nuisance, but the availability of hedging facilities has generally given the buyer effective protection from short-term fluctuations. Unfortunately, the trade in copper on the London Metal Exchange in the past few months has not kept prices down and the relative movements between spot and future prices have not permitted hedging. The thinness of the London Market, due to currency restrictions which prevent producers and consumers from all over the world from dealing on the pre-war scale, has resulted in unrealistic prices. Between September, 1954, and March, 1955, London Metal Exchange export copper prices were on the average £35 a ton higher than the corresponding New York prices. In order to remedy the present evils, the Roan Antelope and Mufulira Copper companies have decided to offer copper at prices which will remain fixed for not less than 30 days to customers " who are willing and able to instil a degree of stability into re-sale prices for copper and brass products." I.C.I., British Insulated Callender's Cables and Enfield Cables have already welcomed the move, which is doubtless for the best in present circumstances. Nevertheless, it is to be hoped that it is only a temporary expedient, and that when the return of fuller currency convertibility again restores conditions favourable to the free market, price-fixing will be abandoned.

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STEEL MARKET DEVELOPMENT

The need for market research is now much more widely appreciated than it was a few years ago. Although still used most in industries making consumer goods, its application is gradually extending to others. A United Nations report, " Recent Advances in Steel Technology and Market Development, 1954," points out that technical progress can be wasted if it is not accompanied by active development of the market. The Americans have been conscious of the need to relate technology to market requirements; European countries have recently been paying more attention to market development, but much more could be done.

Market development not only comprises market research in its narrowest sense, but also covers the examination of all the problems connected with increasing demand for specific products: quality and design, competition with other materials, price structure and sales organisation. Effective market development requires the existence of facilities for maintaining co-operation between an industry and its customers; of machinery to ensure that production facilities can be related to demand; and of measures to promote increased efficiency in product utilisation. In the British steel industry, some of these functions are carried out by such bodies as the British Iron and Steel Federation (who have a Market Development Department) and the British Constructional Steel Works Association. It is, however, as true of the British steel industry as of the European steel industry as a whole that greater resources could with advantage be provided for the conduct of effective market development in its many aspects—particularly at company level. One market research department in the United States steel industry has 106 employees, but in Europe such work is left mainly to national organisations and is rarely done by the companies themselves.

The particular aspects which require greater attention in Europe include wider application of standardisation; adjustment of price structures to provide proper incentive for the greater use of steel in new forms or new ways; closer working relations between steel industry engineers and engineers in consuming industries; and detailed inquiries into the relative merits of steel and other materials in consuming industries. In the United Kingdom much has been accomplished in the development of new types of steel—e.g. the use of tubes for structural steel work, broad-flanged beams, differentially-coated tin-plate—but rather less has been done to meet competition from competing materials. This is only one of the ways in which more intensive market development can ensure that the fullest returns will be derived from the large expansion programmes now being carried through.

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STEEL TECHNOLOGY

In Europe, the Bessemer converter and the electric furnace provide the main challenges to the open-hearth furnace as steel-melting units, and, at present, one-third of the Continental steel output is produced in the Bessemer converter. In the introduction to the report, mentioned in the foregoing survey note, Sir Charles Goodeve, the director of the British Iron and Steel Research Association, states that rapid technical progress is being made, particularly with the use of bottom, side, and top blowing with oxygen or oxygenated gases to reduce the nitrogen contents of Bessemer steel but that the extent to which oxygenated converters displace open-hearth furnaces will depend on the price of oxygen. Electric-furnace steelmaking is steadily advancing as the price of electricity in relation to fuel falls and as the quality requirements go up. The range of economic size of electric furnaces, proposes Sir Charles, is enormous and runs from one to 200 tons. In ten years he adds, the acid open-hearth furnace will disappear in favour of the electric process. In the United Kingdom, some steel will be made using electricity generated from nuclear energy. Sir Charles, moreover, believes that, also in 10 years' time, a large proportion of the more expensive steels will be produced by continuous casting, and thus the ingot stage and the primary rolling mill will be eliminated.

Some data on the continuous-casting process used at the works of Atlas Steels, Limited, Welland, Ontario, Canada, are given in the report. These show that the latest type of machine has four operating levels and can cast slabs having cross-sectional areas measuring from 5¼ in. by 7½ in. up to 5½ in. by 21¼ in., and billets ranging from 4 in. by 4 in. up to 6 in. by 24 in. The length of the slab or billet is limited only by the availability of hot metal but, in practice, they are cut by automatic oxygen torches into 16-ft. lengths. The time required for casting depends on the size of the billet or slab involved, but for the smaller size of billets casting speeds of from 60 to 80 in. per minute have been reached.

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COLONIAL DEVELOPMENT CORPORATION

Frank comments by the Colonial Development Corporation on its unhappy experience due to a troublesome legacy from the past have become quite an accepted feature of colonial development. In 1954, the Corporation had a deficit of £85,946 compared with one of £403,334 in the previous year. There is evidence therefore that the Corporation's record is gradually improving. On the other hand it now has an accumulated deficit of about £9·7 million.

Discussing the factors limiting its activities, C.D.C. says that it has paid heavily for inefficient management and supervision; money has been spent on sterile projects; it has been called upon to undertake the production of foodstuffs and raw materials in competition with established producers in world markets, and such a policy has been to some extent dictated by political and strategic considerations which are bound to work out unfavourably on the profit and loss account unless the market is protected. The Corporation, however, is more optimistic about its future developments. It is now confident that its staff is capable, in association with authority and private enterprise, of contributing fully to the planning and execution of large projects. This, it considers, is the outstanding achievement of 1954. An analysis of the Corporation's capital shows that at the end of last year about half was invested in 28 trading projects and loans, 15 per cent. in 5 projects which were being cut down or reorganised and the remainder was invested in investigations and pilot schemes.

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ENGINEERING IN NORTHERN IRELAND

Unemployment in Northern Ireland has fallen from about 13 per cent. of the labour force of 470,000 in June, 1952, to about 7 per cent. This is due partly to the revival in prosperity of the textile industries, particularly linen. Nevertheless, over 3,000 textile employees are still unemployed, and on the land, where about

5,000 are unemployed, the labour force must continue to decline with the progress of mechanisation. A solution to this problem is as necessary to the political stability of the U.K. as it is to Ulster, and both Governments have done much to foster the growth of new industries there. Under the Re-equipment of Industry Act, the Northern Ireland Government is committed to paying £4 million towards industrial re-organisation schemes which will cost £13 million, and the more recent general provisions of the Capital Grants to Industry Act (Northern Ireland) permits grants of 25 per cent. on all new capital expenditure. Investment per head in new factory buildings in Northern Ireland has actually been higher than in Great Britain as a whole, but much more requires to be done and, despite Government discouragement, there is still too great a tendency for expanding British companies to stick to areas where labour is already short.

Ulster already has a high reputation for engineering products, and there is scope for expansion in light engineering. Unfortunately, shipbuilding and aircraft which account for most of the engineering labour have not been the most stable of industries. But for the recent speedy action of the Ministry of Supply in re-arranging contracts in the aircraft industry, when it was decided to restrict production of the Swift Mark 4, there might have been serious unemployment at Short Brothers and Harland Limited. Other engineering industries are of course, already established. Pye, Limited, and the British Thomson-Houston Company, have large Ulster establishments, but more are required. Even more basic is the need to see that the best use is made of the existing engineering facilities in Northern Ireland.

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CHEMICAL ENGINEERS' HEYDAY

The rapid pace of development in the chemical industry in the past few years has created unique opportunities for chemical engineers, and unfortunately their numbers are still too few in relation to the expansion schemes which are being undertaken. Nevertheless, the rise in productivity in the British chemical industry shows how successful their work has been, as is supported by the views of Sir Harold Hartley that are reported elsewhere in this issue. Output has risen by about 65 per cent. since 1945—proportionately much more than in manufacturing industry as a whole—whereas the labour force has increased by only 18 per cent. Crudely measured, productivity has thus risen by about 40 per cent. The annual rate of investment in chemical production (exclusive of oil-refining) is now about £75 million. The outlay of Imperial Chemical Industries alone since the war must have been about £250 million, and many projects ranging from Terylene to titanium are still to be completed. Among the many projects of other companies is the £5 million sulphuric acid plant, at Widnes, of the United Sulphuric Acid Corporation. Albright and Wilson have spent £8 million on developing phosphorus, phosphoric acid, detergent phosphate and silicone production at Portshead, Kirkby and Barry. Expansion programmes by the Distillers Company have included a heavy outlay on the production of plastics at Barry. The British Oxygen Company are also extending their interest in plastics by devoting about £400,000 out of a total proposed outlay of £5 million to their production in the next two years.

Monsanto Chemicals Limited, who have already spent £11 million on their plants at Ruabon and Newport for the production of polystyrene plastics, additives for lubricating oils, synthetic rubber, chlorine and intermediates for detergents, phthalic anhydride, etc., will be spending a further £2 million in 1955. The company, who now employ about 3,700 people and had a turnover of £12·7 million in 1954, have trebled in size since the war. According to a statement made by the parent American company, British Monsanto are to undertake an outlay of 28 million dols. to increase their capacity by a further 50 per cent. in the next five years. Of particular interest is an announcement that they are proposing to enter the market for synthetic detergents.

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CHEMICAL ENGINEERING AT SWANSEA

An interesting experiment in education is to be undertaken at the new Department of Chemical Engineering at the University College of Swansea, which will take its first students in October next. In the final year a series of " design studies " on actual industrial plant will be carried out. With the co-operation of local industry, the design and operation of different types of equipment and process plants will be the subjects of analytical studies by student teams under the supervision of members of the teaching staff. It is hoped that this may be a preliminary to the establishment of a " Practice School " type of post-graduate course.

There is no place better suited for such a venture. The diversity of industries in the Swansea area, which range from steel and the non-ferrous metal industries through petroleum refining, acids and explosives manufacture to the making of artificial sponges, provide an enviable opportunity for active collaboration between industry and the new department. The course of study reflects the conviction that chemical engineering training is not a narrow specialisation but a broadening of existing courses in applied science, being based on both physics and chemistry rather than on either separately. At the same time, since chemical engineers, like all other engineers, have to learn to deal with problems which at the present stage of knowledge defy full analysis, an emphasis will be placed on the necessity for the acquisition of what may be described as " scientific judgment."

As with other fields of study at the University College of Swansea, it is expected that the course will lead to both pass and honours degrees. The honours degree course is nominally of four years duration, but students with certain advanced level subjects in the General Certificate of Education enter at the second-year stage. The students will take most of the courses arranged by both the Departments of Engineering and Chemistry up to subsidiary level. This, of course, is a feature of almost all existing schemes of study. But at Swansea some of the basic ideas of chemical engineering will be introduced from the start. A " co-ordination course " having the general title Industrial Process Principles will continue throughout the whole period of study.

In the earlier years, when students are spending most of their time studying chemistry and the basic engineering subjects, the significance and relevance of these will be illustrated by considering examples of industrial stoichiometry, material and energy balances, and the conventional separation processes such as distillation, absorption, solvent extraction, and so on. At the same time there will be an appropriate laboratory course. In the final year there will be an emphasis on the study of the transfer of heat, matter and momentum, and the rate at which this transfer takes place. The industrial and technical applications of physical chemistry will also be further studied, and the " design studies " already mentioned will be undertaken.

The head of the new department, Professor E. S. Sellers, has been a member of the staff of the Cambridge University Department of Chemical Engineering since its inception in 1948. The combination of the Cambridge analytical approach with industrial experimentation should produce the type of chemical engineer for which there is such a large unsatisfied demand.

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MACHINE TOOLS

Machine tools are again very much in demand. In particular, the large expansion programmes of the motor-vehicle manufacturers and makers of durable consumer goods have brought a flood of orders for large unit mass-production machines. The extensive reorganisation scheme of British Railways is but one of the influences increasing demand for heavy complex " specials " for such industries as locomotive building and electrical engineering.

Perhaps the brightest feature of the revival in orders for machine tools is the extent to which these include general as well as special machines and are distributed throughout all branches of engineering. In his recent statement, Mr. J. R. Greenwood, chairman and managing director of Craven Brothers (Manchester), Limited, points out that there is a determination throughout all branches of British engineering to increase productive capacity and to eliminate obsolescence. The movement is receiving much of its impetus from the steady reduction in working hours. While formerly engineers did not consider it economic to install expensive equipment unless it could be worked for 5,000 working hours per annum, the shortage of skilled labour is now such that only in exceptional circumstances can anyone put on a night shift. In order that a greater volume of work may be obtained in half the working time, machine tools are required which can be automatically or semi-automatically controlled and work at higher speeds and horsepowers. " It is beginning to look," Mr. Greenwood believes, " as if the automatic factory is indeed in the near future."

As is customary in times of high demand, the machine-tool industry is looking to sub-contractors to augment capacity. Craven Brothers have entered into long-term manufacturing agreements with Urquhart, Lindsay and Robertson Ochar, Limited, of Dundee, and Crossley Motors, Limited, of Stockport. Both these companies will manufacture some of the smaller types of Craven machine tools. Both companies are, of course, already precision engineers in their own lines and Urquhart Lindsay are old-established tool-makers.

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ALUMINIUM PROGRESS

The progress of aluminium in recent years has not, of course, been entirely smooth. It is not so cheap that it can supplant established materials like steel in many of the uses for which it might otherwise be suitable. Demand in some of the uses for which it is particularly suited (as, for example, in aircraft and armaments generally) has fluctuated widely. Fortunately, the industry has been very progressive in market development and the exploitation of many new uses in the major fields of transportation, construction, electrical equipment, household supplies and packaging has ensured that demand has kept pace with the large expansion programmes undertaken since the war. Total world production of aluminium, which has just about doubled in the past seven years, is now at the rate of about 2·5 million tons per annum. The recent statement of Mr. Nathaniel V. Davies, President of Aluminum Limited, of Montreal, shows that that company's sales increased from 370,500 short tons in 1949 to 592,300 in 1954.

Aluminum Limited have now successfully completed the major expansion scheme which they began in 1951, but other projects are just beginning. Capacity at Kitimat, where production started last August, is to be raised to 151,500 tons by 1956, and should eventually reach 550,000 tons. Most of the alumina required will come from Jamaica where it is proposed to raise capacity from 230,000 to 300,000 tons a year and eventually to 500,000 tons. Firm decisions have still to be made about the future of the Volta River Project, which has a potential capacity of 230,000 tons of primary aluminium. The report of the Preparatory Commission appointed by the British and Gold Coast Governments is, however, expected about the end of this year, when the implementation of the project will be further discussed and negotiated by Aluminum Limited.

THE TRANSPORT HELICOPTER

POSSIBLE TRENDS IN DESIGN AND APPLICATION

That the main potentialities of the helicopter, still largely untapped, lie in its ability to pick up and deliver cargo of bulk and shape which render any other method of handling and transportation impracticable was perhaps the main conclusion to be drawn from the James Clayton lecture on "The Transport Helicopter," delivered before the Institution of Mechanical Engineers in London on Friday, April 29, by Dr. Igor I. Sikorsky, engineering manager of the Sikorsky Aircraft Division of United Aircraft Corporation and designer of the first helicopter to go into production. In the first part of his lecture, Dr. Sikorsky traced the history of the helicopter and outlined its valuable accomplishments in military service in Korea, after which he gave an account of recent helicopter activities in transport, prospecting, pest control and rescue operations. Extracts from the main part of his paper, in which he surveyed the lines on which he expected the helicopter to develop, are given below.

For both military and commercial applications, it is possible to foresee, in the immediate future, the development of two distinct classes of transport helicopter. The first would correspond to the airliner or transport aeroplane; the second would be a freight and cargo carrier with virtually no parallel in any other aircraft.

The passenger transport helicopter would be essentially the further development of the helicopter as currently used. This aircraft would carry all its useful load of passengers and luggage or cargo inside its body-fuselage. However, the helicopter may gradually become somewhat different from the airliner. For instance, in the helicopter it would be desirable to use larger entrance doors, or more of them, in order to expedite the loading and unloading of the aircraft for short-range flights, and to use larger windows because, as a rule, the view from a helicopter cabin is completely unobstructed.

THE CRANE HELICOPTER

The second type will be a special freight-cargo helicopter specifically designed to lift any type of object or load, including large and bulky ones, and to carry them on the outside, suspended below the body of the aircraft.

In the crane helicopter it is possible to use any conventional helicopter-lifting rotors and methods of control, power plant, transmissions, etc. The cargo helicopter may virtually have no fuselage-body and may simply be a flying frame or, possibly, have a needle-like fuselage of small cross-section adequate to accommodate the transmission and other accessories, and either a hoist or other arrangement that could suspend and, if necessary, lift the loads.

Study is being conducted as to the best configuration and the best location for the pilot's cabin in such aircraft. The main advantage of an arrangement in which the pilot's cabin would be suspended below a narrow tubular fuselage substantially behind the centre of gravity of the aircraft would be that the pilot would have excellent vision of the object which he is to lift, of the whole procedure of attaching and lifting and, finally, of directing the aircraft in a way that would permit bringing and lowering the object precisely where it may be needed. This would enable, for instance, a transportable house to be carried and lowered directly upon its foundation, and high-tension towers to be delivered in a vertical position and placed accurately on their bases. It would, in fact combine to countless problems of transportation, with the problems of erection. An excellent beginning to such methods has already been made by the Armed Services and private operators, using ordinary helicopters carrying jeeps, pieces of artillery, long pipes, long posts, loads of timber to construct a village of 21 houses, light aeroplanes, helicopter bodies, miscellaneous pieces of machinery and equipment, food, fuel, and a 300-lb. cross which was lifted and set down directly on top of a church steeple. Such were the services rendered by the helicopter with relatively modest power and lifting capacity and with conventional arrangements which did not make it possible for the pilot to see the cargo that was picked up and lowered in place. A cargo helicopter with adequate lifting power and proper location of the operator's cabin will promote, within the next decade or two, a whole series of new enterprises and industries that would depend on the possibility of making direct deliveries of objects which, owing to their length or bulk could not otherwise be transported in assembled, ready-to-use form.

FORWARD SPEED VERSUS HOVERING

There are reasons to maintain that the operating speed of the pure helicopter, in which all lift and forward components are derived exclusively from the action of one or several lifting rotors, will never be much in excess of 200 m.p.h. Methods being studied for the further increase of speed of the pure helicopter include special designs of blades, different types of boundary-layer control and, possibly, the use of supersonic blades. Some type of boundary-layer control to delay stalling would produce interesting results but the increase in speed would not be great.

One of the major problems involved in the use of supersonic rotors is the fact that in forward flight a certain section of the blade would have to make the transition from subsonic to supersonic and back at each revolution. The adverse effect would be tremendous and possibly insurmountable.

Compound Type.—A speed somewhat higher than the velocity of the pure helicopter could be obtained by the use of the compound helicopter or "gyrodyne"—an aircraft which, besides the lifting rotor, has small auxiliary wings and probably propellers or jets. As the aircraft accelerates, the wings will carry part of the load and, with the main rotor being unloaded, it would be possible to postpone or prevent stalling of the retreating blades and consequently exceed the speed range of the pure helicopter by perhaps 50 to 75 m.p.h., or even more.

As a rule, the wings and propulsive members of the compound helicopter would be, at best, useless during hovering. Consequently, with the same hovering ceiling and other conditions, the compound helicopter should have less payload than the pure helicopter of like size and power. Nevertheless, for intermediate ranges, the compound helicopter, with its higher speed may offer sufficient advantages to justify its use.

Convertible Type.—A more radical type, which would offer a considerable increase in speed, would be the so-called convertible helicopter—an aircraft which can take off vertically and hover as an ordinary helicopter and then become converted into an aeroplane and travel at considerable speed. For landing, the aircraft could be reconverted into a helicopter and hover and land in the usual manner. As a general rule, such aircraft would always remain considerably more expensive and less efficient than either the pure helicopter or the pure aeroplane of equal lifting capacity. Therefore, I can foresee only a limited utilisation of the convertible type, mainly for certain specific military uses.

Vertical Take-off Type.—A very promising aircraft of similar potential performance is the vertical take-off aeroplane. I do not believe that it could approach the hovering characteristics of a true helicopter, but it should be capable of rising into the air vertically and landing with no run. Once in the air it would proceed as an aeroplane which, in fact, it never ceases to be. The military value of such aircraft may be substantial.

There are reason to believe that the single-rotor aircraft will remain the most important type, judging from its performance and accomplishments to date. For machines of up to 100 tons or so, the use of engines and a transmission carrying power to the rotor shaft or directly to the rotor hub, seems to be the most practical. At present no hydraulic or pneumatic transmissions could approach the 96 to 97 per cent. efficiency currently reached in well-designed modern metal-gear transmissions of helicopters. Maintenance, life expectancy and reliability of helicopter transmissions are all quite reasonable at the present time and may well be expected, in the near future, to be in line with the characteristics of the best modern aero-engines or turbines.

For still larger machines, it may be advantageous to eliminate the transmission and apply the force directly at the tips of the blades.

While the construction of an aircraft with complete turbo-jet units on the tips of the lifting rotor blades would involve the serious problem of producing a turbo-jet capable of withstanding considerable centrifugal and gyroscopic forces, it would also involve carrying heavy loads on the tips of the blades. In a "super-giant" aircraft of such nature, we may even foresee the blade supported by a landing gear of its own which may be retracted when the blade becomes airborne. Other methods might involve the use of supporting members that would be folded or removed when the blade becomes airborne or when the centrifugal force becomes sufficient to support the blade.

In future helicopters, particularly in the large ones, heavier disc-loadings and ligher power-loadings may be expected. In large rotors it may be advantageous to use a greater number of blades of a moderate chord to increase the smoothness and decrease the control loads.

It is probable that aircraft piston engines will continue to be the principal power plant on helicopters, as at present. However, helicopters will profit even more from the characteristics of the turbine than the aeroplane. Engines with the free turbine wheel would probably be preferable because, in the event of one engine becoming inoperative, it would be possible to obtain nearly the full power of the remaining turbines at a somewhat reduced number of revolutions of the rotor. For single-engined helicopters this would represent no advantage.

NUCLEAR POWER NOT JUSTIFIED

The major problem in using nuclear power for helicopters would be to protect the occupants from the powerful radiation from the nuclear reactor. On a sufficiently large machine, a reactor could be situated in the remote bow of the aircraft fuselage and be properly insulated, while the crew could be located in the rear end of the craft. The entire aircraft, however, including transmission and rotor blades, might become powerfully radio-active and the blades, in turn, would spread radio-activity on all parts of the aircraft.

Another method would be to separate completely the reactor, together with turbines, into one unit that could be carried by the helicopter, suspended on a length of cable. By insulating either this unit or the crew compartment, or both, it would perhaps be possible to protect the occupants of the aircraft. However, in this case, transmission of power would present a serious problem.

A reasonable method would be to use the power of the turbine to generate compressed air which could be sent by conduit up into the aircraft where it could operate power turbines or jets. This, however, would still involve the danger of the stream of air itself becoming infected with radiation which it would carry up into the aircraft. A safe way would be to generate electric current in the suspended reactor and send it up into the helicopter by conductors. However, while some optimists believe that extremely lightweight generators and electric motors—weighing less than 1 lb. per horse-power—are possible, electrical equipment so far produced has been much heavier.

The best arrangement appears to be the reverse one. Let us suppose that the reactor, with all its accessories and the turbines directly geared

to the rotor, are located in the cabin of the aircraft, while the crew are all in a separate cabin which is normally suspended under the helicopter on a cable a couple of hundred feet long, and which, in fact, is never expected to be closer than that distance to the carrier helicopter. Controls will be transmitted from this suspended cabin into the helicopter by electricity, etc.

A conventional arrangement may become possible if lighter and more efficient methods of protective insulation are developed. The greatest obstacle, which will probably prevent the use of atomic energy in helicopters for some time to come, is the fact that there may not be sufficient advantage in doing so. Practically all the missions of the helicopters are for short range. Consequently, it does not seem that the use of a delicate and very expensive source of power would be justified.

SHAFT DRIVE PLUS TIP JETS

In the medium-size and large-size helicopters, it may be advantageous, in the future, to use a combined system of applying power. This would consist of engines or turbines the power of which is geared to the main rotor shaft or, in larger units, preferably directly to the huge rotor-hub of the aircraft. A secondary power system would consist of a turbine or turbines driving compressors, sending compressed air through the blades and using jet power at the tips of the blades with or without superheating it.

In the proposed arrangement it would be possible to utilise passages within blades of normal cross-section which, as a rule, are smaller than would be desirable if pure pressure-jet drive were used. Furthermore, it would permit using the light but inefficient jet system for take-off, or for any time when a burst of power would be needed, while for ordinary cruising, it would be possible to operate under the more efficient engine-and-transmission system.

In helicopters of, say, more than 100 tons gross weight, it may be advantageous to apply all or most of the power directly at the outer ends of the blades in the form of either pressure jets, or complete turbo-jets mounted on the tips of the blades, to eliminate the torque stresses in the centre of the craft and the torque compensating device. So far, however, no arrangement of this nature has been tested that would approach the efficiency and general operating characteristics of a helicopter, with a transmission and a torque-compensating control rotor. If mechanical transmission is retained on giant helicopters, it may be advantageous to use hydraulic, pneumatic, or electric transmission of power to the tail rotor, or to use a separate power plant, say, two governor-controlled turbines, to generate the power for the tail rotor where it is required.

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Letters to the Editor

TECHNICAL STAFF FOR BRITISH RAILWAYS

Unattractive Conditions for Chartered Engineers

SIR, The British Transport Commission's plan for the rehabilitation of the railways includes the recruitment of additional technical staff to implement the plan. To obtain this staff Sir Brian Robertson has stated: "In future the best possible advertisement for a career on the railways should be the plan itself." What a hope! Even the most credulous of young graduates is likely to murmur something about salary before attaching himself to a plan.

What can the British Transport Commission do about this delicate matter? Advertise vacancies at the existing scales of salaries for professional and technical staff or offer higher salaries to attract recruits? If the first course is followed, recruits of ability will not be attracted. If recruits are offered higher salaries this will not make for smooth working within the organisation and will only make an unhappy section of the staff even more unhappy. It may appear to be a very dogmatic statement to say that existing railway scales for technical staff will not attract, but is it generally known outside railway circles how low these salaries are, how slowly the staff rise, and the parsimony with which the administration reward the technically qualified?

ENGINEERING and other prominent technical journals have commented on there being only 400 chartered engineers—civil, mechanical and electrical—in the employ of British Railways. To those in the railway service the reason is not hard to find: there is no reward for the qualification, and an institution subscription to pay from a meagre salary. The railways do, indeed, pay additions for technical qualifications, but the awards only apply to Class A of the P. and T. (professional and technical) staff, i.e., the lowest grade;* for Sections A and B of an institution's examination, £25 a year; for Section C a further £25; and for election as an associate member a further £25.

As soon as the Class A recipient of any of these awards is promoted, he loses his awards. No young man with a degree or Higher National Certificate is going to be content to remain on the lowest grade; if promotion does not come his way, he will leave the railway service. The railways are losing technical staff at the rate of 20 to 30 a year. The whole policy appears to be designed to discourage membership of the professional institutions. The British Transport Commission might well offer the £75 per annum award to all staff who are chartered engineers irrespective of the position they hold. It would be just as much a reward for studies in the past to the higher officers, as it would be encouragement to the young engineer to qualify.

As an actual example of the salary scales, the writer has been a chartered engineer since before the war, i.e., has held a position of responsibility for 15 years, and has since advanced in the railway service, but is not yet earning enough to pay income tax at the standard rate. A possible reason for the low level of salaries for the technically qualified is that the administrative and staff-officer grades are in the main filled by clerical grades who have attained these positions by merit and by virtue of their experience, but who have never passed open examinations of any outside body. These officers are not to be expected to support with enthusiasm higher scales of salaries for the technical man, to which, for lack of qualification, they themselves could not attain.

Caution prompts me to sign myself,

Yours faithfully,

ONE OF THE FAITHFUL FOUR-HUNDRED.

(*Name and address supplied*)

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THICK-WALLED CYLINDERS UNDER INTERNAL PRESSURE

Fortuitous Agreement between Formula and Result

SIR, We should like the opportunity to reply to the second letter (in your issue of April 29) written by Professor van Iterson on our article on the ultimate strength of thick-walled cylinders.

For the shear stress-strain curve shown in Fig. 1, the cylinder would initially yield at the bore at a pressure

$$P_1 = q_1 \frac{(K^2 - 1)}{K^2} \quad . \quad . \quad (1)$$

If the pressure is raised further the yield will extend into the cylinder wall. The boundary between the yielded and the elastic portions of the cylinder will be circular and concentric with the cylinder provided that the drop of stress at yield in shear is not excessive. The pressure required to give complete yield throughout the cylinder is given by

$$P_2 = q_2 \log_e K^2 \quad . \quad . \quad . \quad (2)$$

If the yield criterion is assumed to be given by the maximum shear stress, then equation (2) can be expressed

$$P_2 = y \log_e K \quad . \quad . \quad . \quad (3)$$

where y is the plastic or lower yield stress in tension.

When this pressure P_2 is reached, the cylinder continues to expand, and, because the value of K becomes less, the pressure which it would hold decreases; that is, the cylinder, becomes unstable after a pressure P_2 is reached. Normally, however, the material would begin to strain-harden after a relatively small plastic strain, as shown in Fig. 2, and stability is again achieved due to the increased stress which strengthens the cylinder. Instability, nevertheless, will again be reached at a much larger strain when the increase in strength caused by strain-hardening is just offset by the weakening effect arising from a decrease in K. It should be pointed out that K at this point of instability is appreciably less than its initial value. For instance, cylinder 13 had a K of 3·717 before testing and at the ultimate pressure K was 2·81.

Professor van Iterson suggests that the pressure at this point of instability is given by substituting the engineer's ultimate stress R for y in equation (3) to give

$$P = R \log_e K \quad . \quad . \quad . \quad (4)$$

This substitution seems totally unjustified for the following reasons: (*a*) the engineer's ultimate stress is not a true stress as it is based on the original area of the specimen; (*b*) the stress across the wall of the tube at the ultimate pressure is not uniform as in a tension test; (*c*) the value of K at the ultimate pressure is considerably less than its original value. The effects of (*a*) and (*c*) tend to cancel one another so that equation (4) gives figures which are not seriously in error, but it is still the authors' opinion that the approximate agreement is fortuitous.

If an approximate equation is required it would seem that the mean-diameter formula, which at least has some theoretical justification, is not only simple but agrees well with the results. The authors would, however, again point out that this good agreement may not necessarily hold for all materials, and one of us is at present engaged on further tests with this point in mind.

Yours faithfully,

B. CROSSLAND,
J. A. BONES.

University Engineering Laboratories,
University-walk,
Bristol, 8.
April 15, 1955.

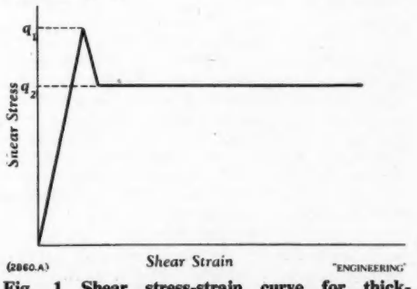

Fig. 1 Shear stress-strain curve for thick-walled cylinder, showing instability after yield has occurred throughout cylinder.

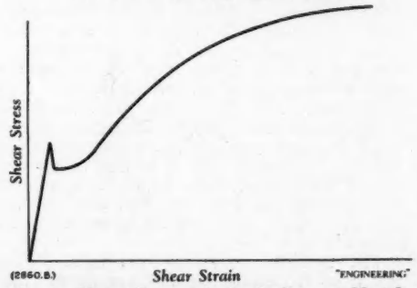

Fig. 2 Normally, work hardening would take place after a relatively small plastic strain and stability would be temporarily restored.

* There are three grades: A, B and C, of which C is the highest.

CHEMICAL ENGINEERING—THE WAY AHEAD

The Presidential Address to the Institution of Chemical Engineers was given by Sir Harold Hartley, K.C.V.O., C.B.E., M.C., F.R.S. on Tuesday, April 26. Extracts from the address, "Chemical Engineering—the Way Ahead", are given below.

Three years ago I spoke to you of "Chemical Engineering at the Cross Roads" and of the signs and warnings that indicated the direction along which we ought to travel. We have gone a long way since then on the right road and made much progress. We can see the way ahead. To-day, there is a much more general understanding in Britain of the role of the chemical engineer; he is no longer regarded as a misnomer or a curiosity, and there is a much wider recognition of the contribution that he can make in industry. Chemical engineering laboratories are being accepted as a necessity in many modern industries. The next few years should see a large increase in the output of chemical engineers from the new departments that will give chemical engineering its place in the engineering schools of most of our universities. New laboratories and larger staffs will expand rapidly the volume of research that is so badly needed. Methods of teaching are being revised to give the young chemical engineer the adaptability and flexibility of mind that he needs to face new problems over an ever widening field of activity, where success depends on an analytical approach to an experimental attack with access to accumulated scientific and engineering knowledge and experience.

EXTRACTIVE METALLURGY

We are living more than ever in a machine age. Everything is being mechanised to save human labour and effort, and speed up productivity. With that goes an increasing demand for metals, and in spite of alternatives like plastics and bonded materials and the use of scrap the demands for virgin metal are rising. There is also the increasing use of new metals like titanium, zirconium and beryllium. At the same time many of the richer ore deposits are being depleted and we are dependent more and more on lower-grade ores often containing a mixture of minerals which are very finely disseminated. For the treatment of these the older physical methods of ore dressing producing concentrates for smelting are proving inadequate, and they are now being supplemented by various chemical-engineering techniques. There are two main developments; first, the recent extensions of the old method of leaching the ores or the tailings from previous extractions with solutions, sometimes under pressure, to dissolve out the metal contents, and secondly the treatment of the ores in a fluidised bed. The advantage of the leaching process is that it can be used for very low-grade ores and allows the separation of different metals by a variety of different methods, precipitation, electrolysis, solvent extraction or extraction by ion-exchange resins. Thus uranium is recovered from the tailings on the Rand by leaching with sulphuric acid and ion exchange. Manganese can be recovered from low-grade ores or open-hearth slags by leaching with sulphur dioxide, or by preliminary roasting in a reducing atmosphere followed by leaching with ammonia and carbon dioxide or with nitric acid. Nickel sulphide concentrates are being leached with aqueous ammonia and oxygen under pressure giving ferric hydroxide and a solution of the amines of nickel, cobalt and copper from which they can be separated. A large ore deposit containing less than one per cent. of copper oxide is being leached with sulphuric acid.

The fluidised bed-method of treating ores under controlled-temperature conditions with various gases also offers a number of possibilities. Iron oxide can be reduced to magnetite for magnetic extraction and commercial plants already exist for using this technique for roasting pyrites. Copper nickel and cobalt ores can be converted to sulphates or chlorides by treatment with sulphur dioxide or chlorine in a fluidised bed, followed by leaching with water. Manganese in low-grade ores can also be converted to sulphate in the same way.

BIOCHEMICAL ENGINEERING

Three years ago I drew your attention to the growing importance of applied microbiology or biochemical engineering as I prefer to call it. I compared the limitations of the man-made catalyst with the ability of the enzyme systems to build the most complex proteins and polysaccharide molecules by their template methods with a cleanness and efficiency that we can never hope to emulate without their aid. Since then rapid progress has been made and the growing industrial importance of this field has been recognised, in the United States for instance, by the new Institute for Research in Microbiology, at Rutgers University.

Meanwhile I have been criticised for suggesting that there is anything new in biochemical engineering, which my critics say is just the application of living catalysts in place of, let us say, platinum, and that it needs no new techniques. My reasons for differing from this view are quite simple. During the lifetime of an inorganic catalyst it will continue to exert the same influence on any given chemical system with declining activity as it is gradually "poisoned" or rendered inert. The living cell is entirely different as it often passes through various metabolic changes in its lifetime when its growth phenomena and its excreta undergo radical alterations on which its industrial application must be based. There are, too, such phenomena as the rapid alternation of light and dark reactions in the metabolism of photosynthetic organisms like chlorella of which its industrial use must take account.

INSTRUMENTATION AND AUTOMATIC CONTROL

In the chemical and process industries the whole tendency is towards continuous plants with the economies they offer in capital cost, manpower and throughput—whenever the volume of production is sufficiently great. Such continuous plants have demanded a large amount of instrumentation and automatic control, and one of the main purposes of a pilot plant is to investigate the instrumentation required. In many cases the plants have been designed and the instruments and control added later and in fact all processes are really manually controlled because every major load change in general requires re-setting to the desired values of all the controls. Electronic devices are much quicker and more accurate than the human senses and with appropriate servomechanisms they offer great advantages. With the rapid advances in the design of automatic controls, design engineers have been able to make considerable improvements by the incorporation of the latest standard instruments as they come on the market. Recently this approach to the process design problem, the addition of controls to process flow sheets, has reached something of a stalemate. It is now clear that the major advances will only be achieved if the use of automatic control is considered in the earliest design stages. This means that there must be consultation between the chemical engineer and the automatic-control engineer from the earliest stages and a sympathetic understanding between them.

We must move on from the stage of adding process controls in an empirical manner. This is not an easy matter, however, and it will call for a basically new approach to the problem of process design. Two difficulties appear to stand out. First there is a grave shortage of automatic-control engineers with the necessary experience. Coupled with this is the shortage of chemical engineers with sufficient understanding of the theoretical approach to automatic control. Secondly there is an almost complete lack of the information on plant and process characteristics which is required to enable automatic controls to be applied in a scientific way. Thus we have to face a dual problem of education and training on the one side and lack of quantitative data on the other.

It is easy to illustrate the latter point by comparison with the method of design and automatic controls for mechanisms like gyrostats or rolling mills in which the dynamical characteristics of the various elements are known. In the case of their inertia, for example, theory can be applied to control design, and the results tested in an electronic simulator in which the effect of variations in the mechanism or the control equipment can be seen in an oscilloscope, thus making it possible to design the best types of control for the purpose in question.

This is rarely possible at present with a process at the flow-sheet stage of design, because the essential data concerning the effects of disturbances on the operation of the units of the process are unknown. The research chemist hitherto has only been interested in investigating a steady state. A two-fold approach is necessary. On the one hand the characteristics of the plant, its reactions to disturbances, can be investigated on the laboratory and semi-technical scale and compared with theoretical predictions, thus building up a body of tested knowledge and technique with which to predict the characteristics of a full-scale plant. On the other hand, it is essential that every opportunity should be taken of determining the reactions of plants to disturbances in their working conditions so that we can accumulate a body of knowledge of their dynamic characteristics, which can then be correlated with the predictions of their behaviour based on theory checked by laboratory and semi-scale investigations. Only in this way will it be possible gradually to accumulate data and experience of plant characteristics in order to apply theory with confidence to determine the design and method of operation to give the most economical results by means of quality control. In this connection it is most encouraging to see that Imperial Chemical Industries are now extending very considerably their Central Instrument Laboratory.

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THE INSTITUTION OF CHEMICAL ENGINEERS

Annual Dinner

When proposing the toast of the Institution of Chemical Engineers at the annual dinner of the Institution, held at the May Fair Hotel, London, on April 26, H.R.H. The Duke of Edinburgh, K.G., F.R.S., said that there were not sufficient chemical engineers to meet the needs of industry at present. More and more materials were being processed requiring the services of increasing numbers of qualified chemical engineers. Of late years, however, several universities had created new departments to train students in this subject and the two most recently established chairs in chemical engineering were those at Edinburgh University and at Swansea, in the University of Wales. In the course of his reply to the toast, the President, Sir Harold Hartley, K.C.V.O., C.B.E., M.C., F.R.S., recalled that the Duke of Edinburgh had been his successor as President of the British Association. Sir Harold then proposed the toast of the guests, to which Dr. Alexander Fleck, F.R.S., replied.

After the speeches, Sir Harold Hartley invested his successor, Mr. John A. Oriel, C.B.E., with the chain of office and inducted him into the Presidency. Mr. Oriel's first duty as President was to present the Osborne Reynolds Medal to Sir Harold. It has been awarded this year to Sir Harold for his work in connection with the education and training of chemical engineers.

PERSONAL

SIR LEONARD LORD, K.B.E., chairman and managing director of the British Motor Corporation, Ltd., has been elected President of the Institution of Production Engineers, 10 Chesterfield-street, London, W.1, for 1955-56. He will take office on July 1, 1955.

To mark his 80th birthday (which occurred on April 26), SIR WILLIAM J. LARKE, K.B.E., D.Sc., M.I.E.E., M.I.Mech.E., has been made an honorary Fellow of the Institute of Welding and has been presented with an illuminated address on behalf of the Institute and the British Welding Research Association.

DR. WILLIAM REID, B.Sc., has been elected President of the Institution of Mining Engineers, 436 Salisbury House, Finsbury-circus, London, E.C.2, for the year 1956-57. He will succeed MAJOR NOEL WEBSTER at the 62nd annual general meeting, to be held in London early in 1956.

DR. HORACE W. CLARKE, F.I.M., chairman and managing director of James Booth & Co., Ltd., has been elected President of the Aluminium Development Association, 33 Grosvenor-street, London, W.1.

MR. J. S. BEVAN, hitherto assistant managing director of the Union-Castle Mail Steamship Co., Ltd., 3 Fenchurch-street, London, E.C.3, has been appointed deputy managing director of the company. With a view to making way for younger men on the board, MR. A. H. MILBOURNE and MR. JAMES GRAY, C.B.E., have tendered their resignations as directors, as from April 26. To fill the vacancies, LORD MACLAY, K.B.E., and MR. R. M. TURNBULL have been co-opted to the board.

MR. E. D. KNIGHTS, B.Sc.(Lond.), F.I.M., research metallurgist, British Railways, Derby, has been elected President of the East Midlands Metallurgical Society. He succeeds DR. H. K. M. LLOYD, B.Sc., Professor of Metallurgy, University of Nottingham.

MR. GEORGE BAXTER, O.B.E., M.I.C.E., M.I.W.E., city water engineer, Edinburgh, has been made a member of the Fisheries Committee advising the North of Scotland Hydro-Electric and the South of Scotland Electricity Boards. He succeeds MR. WILLIAM GRAY, M.B.E., M.I.Mun.E., M.I.W.E., a former water engineer of Ayr County Council, who has resigned on health grounds.

MR. A. M. WORSWICK, A.M.I.Mech.E., formerly chief designer, press division, Foster, Yates & Thom Ltd., has been appointed chief engineer, Towler Brothers (Patents) Ltd., Electraulic Works, Rodley, near Leeds.

MR. A. E. H. BROWN, T.D., M.Inst.T., at present chief docks manager, South Wales Docks, has been appointed general manager, Scottish Region, British Railways, in succession to MR. T. F. CAMERON on the latter's retirement in September of the present year.

CAPTAIN R. J. THOMAS, master of the British Railways S.S. "Princess Maud" (on the Holyhead-Dun Laoghaire service) has been appointed dock master at Garston, British Transport Docks.

MR. D. W. L. MENZIES, managing director of Bonnington Castings Ltd., Leith, has joined the board of Sigmund Pumps, Ltd., Team Valley, Gateshead, 11.

MR. P. J. OSBORNE, depot manager, Port Said service depot of the Marconi International Marine Communication Co., Ltd., since 1949, is to return to the United Kingdom for leave and subsequent reappointment. His place will be taken by MR. G. A. DWYER.

MR. C. D. H. WEBB, executive director of the Plessey Co., Ltd., Ilford, Essex, has been appointed director of Plessey International Ltd.

In connection with our announcement on page 363 of our issue of March 25, that MR. J. R. DALLMEYER, B.Sc., had been confirmed in the position of assistant civil engineer, Eastern Region, British Railways, we regret that we referred to him as an A.M.I.C.E. He has been a full member of the Institution since January, 1949.

Consequent upon the inauguration of the X-ray department of the METROPOLITAN-VICKERS ELECTRICAL CO., LTD., Trafford Park, Manchester, 17, which department took over the business of the subsidiary company, NEWTON VICTOR LTD., at the beginning of the year, the branch offices of Newton Victor were amalgamated with the district offices of the Metropolitan-Vickers Co. MR. H. B. GOUGH, Assoc.I.E.E., has been appointed sales manager, X-ray department, and MR. G. E. H. DEADMAN, B.Sc. (Birmingham), MR. R. B. GOUGH (London), MR. A. R. HOLDSWORTH (Sheffield), MR. D. MOODIE (Glasgow), MR. H. A. RYDER (Cardiff) and MR. J. TAYLOR (Manchester) have been appointed superintendents, Newton Victor Sales, in the districts stated. MR. F. W. WATERTON, M.I.E.E., had previously been appointed assistant chief engineer, X-ray department, Finchley Works. MR. A. K. NUTTALL remains chief engineer, X-ray department, and MR. J. T. THORNHILL, works manager, Motherwell and Finchley Works.

MR. R. J. DIXON, A.M.I.P.E., chief engineer of Wickman Ltd., Banner-lane, Tile Hill, Coventry, has been elected a director of the company.

MR. E. A. O'NEAL, JR., chairman of Monsanto Chemicals Ltd., 8 Waterloo-place, London, S.W.1, has been elected to the board of the Monsanto Chemicals Co., St. Louis, U.S.A.

The Stockholm headquarters of the Atlas Diesel organisation announce that MR. ERIK RYD is to be technical director in charge of the design, research, and experimental departments. The new sales director of the Atlas Group is to be MR. J. A. PERHAM, who has been managing director of Atlas Diesel Ltd. in Britain since 1952. MR. J. C. GREIG has been appointed managing director of the British Company.

MR. H. H. BEGENT, M.I.E.E., has rejoined the English Electric Co., Ltd. as deputy sales manager of the transformer department, Stafford.

MR. W. J. M. COOK, F.R.I.C., has joined the staff of the Paterson Engineering Co. Ltd., Windsor House, Kingsway, London, W.C.2, to take charge of the industrial sales division.

MR. S. A. SPRAGG has been appointed sales representative of Slack, Sellars & Co. Ltd., saw manufacturers, Mowbray-street, Sheffield, 3.

MR. J. M. WIMHURST has been appointed technical representative for Macrome Ltd., and Hallmac Tools Ltd., Macrome-road, Wolverhampton, for South Lancashire, Cheshire and North Wales.

MR. H. SARGENT retired from the office of secretary of Thompson Brothers (Bilston) Ltd., on May 1, and MR. A. E. P. TURNER, A.C.A., A.M.I.I.A., has been appointed director and secretary from the same date.

MR. E. J. EDWARDS has been appointed branch manager of the London office of the Brightside Foundry and Engineering Co., Ltd., Craven House, 16 Northumberland-avenue, W.C.2.

* * *

COMMERCIAL

KERRY'S (GREAT BRITAIN) LTD., Warton-road, Stratford, London, E.15, have re-opened their Croydon branch. Destroyed by enemy action in 1941, a new building has been erected on the original site, 468-472 London-road, Croydon, Surrey.

MONKS & CRANE LTD. have opened a branch office at 23 Dean-street, Newcastle-upon-Tyne.

HEAD, WRIGHTSON & CO., LTD., Teesdale Iron Works, Thornaby-on-Tees, have acquired from the BRITISH METAL CORPORATION LTD. the entire share capital of COLLIERY ENGINEERING LTD., Sheffield, and its subsidiary company, the CUPOLA MINING AND MILLING CO. The board of Colliery Engineering Ltd. has been reconstituted as follows: MR. PETER WRIGHTSON, chairman; MR. L. W. NEEDHAM, managing director, and MR. H. CUSSONS and MR. S. A. CASSON, directors. The Cupola Mining and Milling Co. is now a direct subsidiary company of Head, Wrightson & Co. SIR JOHN WRIGHTSON, Bt., has been appointed chairman, MR. A. CHILTON, managing director, and MR. PETER WRIGHTSON, MR. L. W. NEEDHAM and MR. H. CUSSONS, directors.

BORAX CONSOLIDATED LTD. have moved to Borax House, Carlisle-place, London, S.W.1. (Telephone: VICtoria 9070.)

B.S.A. TOOLS LTD. have established a separate small-tool export department at their Sparkbrook factory, and all correspondence relating to small-tool export sales should be addressed to B.S.A. Tools Ltd., Small Tools Division, P.O. Box 232, Montgomery-street, Birmingham, 11. MR. E. J. ABBEY has been appointed export manager, and MR. J. D. WILLCOCK, assistant export manager, small-tools division. Export sales of machine tools will continue to be dealt with at the head office, Mackadown-lane, Kitts Green, Birmingham, 33.

A new experimental and development establishment has been opened by COMPOFLEX CO., LTD., of 26 Grosvenor-gardens, London, S.W.1. The new centre is at Godalming, Surrey, and will be in the charge of MR. J. MOSELEY, technical director, with two assistants, MR. D. J. SAUNDERS, chief development engineer (hydraulics) and MR. P. W. O'BRIEN, technical manager (special projects).

GEO. SALTER & CO. LTD., West Bromwich, Staffordshire, inform us that their telephone number is now West Bromwich 1855.

OBITUARY

We regret to record the deaths of:

MR. WILLIAM BROWN PICKERING, on April 24, at the age of 87. Mr. Pickering retired on March 31, 1945, from his offices of commercial manager and director of Hadfields Ltd., East Hecla Works, Sheffield, 9, after a period of service with the company extending over 53 years. Mr. Pickering was a former President of the Sheffield Chamber of Commerce; chairman of the General Steel Castings Association, Steel Castings Manufacturers' Association, and Sheffield and District branch of the Federation of British Industries, and a member of the Grand Council of the Federation of British Industries.

MAJOR STEPHEN JOHN THOMPSON, D.S.O., D.L. Hon.M.I.Mech.E., on April 30, at the age of 80. Major Thompson was a governing director of John Thompson Ltd., Ettingshall Engineering Works, Wolverhampton. He served as President of the Institution of Mechanical Engineers in 1942. We intend to publish a memoir of Major Thompson next week.

* * *

RESEARCH CENTRE FOR BUILDING CONTRACTOR

John Laing's Premises

"The object of research was to make industry more efficient," said the Rt. Hon. Nigel Birch, O.B.E., M.P., the Minister of Works, when he recently opened the research and development centre of John Laing and Son, Limited, at Boreham Wood, Hertfordshire. Although, he added, a great deal of research was undertaken by his own and other Government departments, particularly the Department of Scientific and Industrial Research, it was essential that they must be supported by the leading firms who should themselves participate in the work.

Although much of the work to be undertaken at Boreham Wood will be routine testing and inspection, it is proposed to undertake long-term research and development on a considerable scale in all phases of building science. In particular, work is already in progress on improving plant for mixing, placing and compacting concrete, and trials are being conducted on lightweight aggregates from pulverised-fuel ash, and on a lightweight concrete, "Thermalite."

The new premises are now complete. Modern in design, spacious, airy and well equipped, they extend over 30,000 sq. ft. of floor space. The establishment comprises the following main sections: Plant Development, Mechanical and Electrical Engineering, Concrete and Soil Mechanics Laboratories, Research and Experimental Sections, Architectural and Structural Engineering Development Groups, and a technical library. Besides the laboratories and offices, the premises include a mechanical workshop for pilot-plant production, various stores and ancillary buildings for screening, drying, crushing and steam-curing, and an area for field trials.

The laboratory sections have ample space and a full range of up-to-date equipment. They include a chemistry laboratory for analytical work on building materials; a physics laboratory for the study of materials and where, among other tests, performance under high temperatures can be measured; and a paint and bitumen laboratory with facilities for physical and chemical standard tests on paints and for measuring ductility, penetration, and strength of bituminous material. The concrete laboratory is equipped with continuous temperature control, mist-spray curing room, and a range of test equipment for concrete samples. Aggregates and sands can also be examined, and an aggregate "museum" has been started that will eventually consist of card-indexed samples of aggregate from every part of the country, so that wherever a new contract may be started information on aggregate sources will already be available. The soils laboratory is equipped for testing samples brought up from site areas by borings. Finally, there is a large structures laboratory, where full-scale loading tests can be undertaken, and where building shells can be erected under controlled conditions.

ELECTRICAL DEVELOPMENT CONFERENCE

ENCOURAGEMENT OF "OFF-PEAK" CONSUMPTION

The annual conference of the British Electrical Development Association, which is organised "for the free discussion of sales management problems amongst representatives of the electricity supply industry from all parts of the country," was held in London from Tuesday, April 26, to Friday, April 29. The first meeting took place in Caxton Hall, Westminster, Mr. S. F. Steward being in the chair, by which time 830 delegates had registered.

In opening the conference Sir John Hacking said that the subjects they were to discuss were of importance for the future. The development of the use of electricity was one of the principal means of improving the standard of living. In carrying out that task since the war they had suffered many frustrations, including a shortage of generating plant and an embargo on promotional activities. Shortage of plant was now a thing of the past and salesmen were free to encourage the use of electricity to their hearts' content in a market ripe for the purpose.

He was glad to see that the improvement of load factor was one of the subjects that was to be discussed as it would become more urgent as the plant programme developed. The search for higher thermal efficiency in generation would mean that running costs would decrease but capital charges would go up. He therefore wondered whether the industry was looking ahead sufficiently energetically to the period when lower night rates would improve the load factor, even though this might be accompanied by some increase in the fixed charges.

IMPROVEMENT OF LOAD FACTOR

A paper entitled "Some Observations on the Improvement of Load Factor" was then presented by Mr. S. W. Hazell. A wide diversity of demand and the encouragement of use over extended hours were, he said, essential if high system load factors were to be obtained. The overall price which the Area Boards paid the Central Authority for their energy depended on the load factor and an examination of the relationship between these two items showed that it might be justifiable to sell new loads at less than the existing average cost.

Since the war load development had tended to smooth out the day time load curve; and generally speaking, the times when more electricity could be supplied without risk of affecting the peak were at night, in the afternoon, at week ends, in the summer months, and on holidays, although the last was of no practical value for load building. As it was difficult to carry out plant maintenance when the load factor exceeded 60 per cent., this might for the time being be regarded as the target figure. The national system load factor was now of the order of 48 per cent., so that work could be continued for an increased use of supply. Broadening the peak by one hour in the Eastern Electricity Area would improve the load factor from 42·5 per cent. to 44·8 per cent., and lead to a saving of some £370,000 per annum. There was therefore plenty of room for the development of shift working to the advantage of the electricity supply industry in regard to load factor and indeed to industry generally.

EFFECT OF FULL EMPLOYMENT

Full employment meant more house owners with improved standards of amenities, and in this field a contribution of the utmost benefit to the long-term economy of the electricity supply industry was the use of the off-peak thermal storage heater. It was necessary therefore for them to become better informed of the effect of this load on their operations; and a statistical investigation should be made so that basic data was available. For comfort and convenience in the form of warmth, hot water and laundry equipment were high on the list of benefits.

While it might be conceded that the public now accepted electricity as a clean and convenient service, other factors tended to modify this acceptance. Some architects, and others concerned with new buildings, persisted in the notion that it was in the national interest to employ other fuels. To combat this situation it was necessary for the commercial staff to understand clearly that the success of the industry depended upon the improvement of the load factor obtained by the development of a balanced diversified load, free from restriction or control by switching or otherwise.

SPACE HEATING PROBLEMS

At the meeting on Tuesday afternoon, April 26, Mr. L. Howles was in the chair and a paper on "Electric Space Heating," the chief purpose of which was to discuss the various methods available and their suitability for dealing with different problems, was read by Mr. E. M. Ackery. The rate at which heat was transmitted through the structure was the chief factor in determining the size of installation required and the fuel consumption. In the great majority of buildings heating was necessary for the benefit of the occupants and so long as they were comfortable nothing more was required. Occupation, however, varied from the continuous, for example in hospitals, to only a few hours a week, as in churches.

In the case of buildings that were only intermittently occupied any heat that was supplied during periods of non-occupation was strictly speaking wasted. This waste was unavoidable as far as the thermal storage capacity of the building was concerned. That due to the storage capacity of the heating system could, however, be reduced by utilising equipment with little storage capacity. There would only be a saving in fuel consumption due to intermittent heating if the building temperature actually fell when the supply of heat was shut off. In a lightly constructed building with non-storage heating the drop in temperature would be rapid and the saving by intermittent operation relatively great. If the heating system had large thermal storage capacity, the building temperature would fall more slowly. In a very massively constructed building the drop in temperature would be slow whatever type of heating was employed and a non-storage system would not show much, if any, advantage over a storage system. Whatever the construction of the building the less the occupational period the greater would be the saving in fuel owing to the use of heaters with small storage capacity.

These arguments were supported in the paper by a number of figures of consumption with various types of heaters installed in buildings of different characteristics. Off-peak operation was, however, as important as consumption and the consumer must be given some financial incentive to adopt it. At present the whole financial structure of electric space heating was artificial owing to the uneven incidence of purchase tax. Ordinary tubular heaters, convectors, oil and water-filled radiators, panels and electric fires were all subject to purchase tax. Industrial tubular and unit heaters, electric boilers, block storage radiators and floor heating were, however, not subject, although the use of storage block heaters in domestic premises was prohibited. The whole business was therefore illogical since while the domestic consumer was denied the use of this form of heater, which was well suited to his needs, if he wished to use "off-peak" current he must put in floor heating or a thermal storage installation.

Many factors operated against the wholesale development of truly all-electric domestic space heating; on the supply side the size of the load and on the consumers' side the running cost and affection for traditional methods of heating. The electricity supply industry was, however, physically capable of dealing with a substantial number of all-electric householders and there were, say, 285,000 householders, with a potential load of 6 kW per dwelling, who could afford the convenience of all-electric operation.

On subsequent days papers were read on "Publicity," by Mr. D. Atkins; on "Retail Selling," by Mr. R. G. Magnus-Hannaford; on "Domestic Sales Development," by Mr. E. C. Lennox; and on "Demonstration as an Active Force in Load-Building," by Mr. N. H. Bridge. At the concluding meeting, which was held at the Connaught Rooms, Kingsway, on Friday, April 29, with Mr. V. W. Dale in the chair a general discussion took place on the proceedings of the conference.

* * *

CO-OPERATION IN BUILDING

In 1943 there came into being a commercial building enterprise, the ARCON Group, which cut right across the conventional British pattern of an independent professional consultant working in conjunction with a public works contractor. The Group will consider a project from the earliest moments of its conception and then carry through the design and construction to completion.

The Group is to be distinguished, however, by more than its ability to tackle building problems from the earliest stages to completion. Research and development of new materials and techniques in building are the function of the Group which consists of representatives from five member firms together with consulting architects. The member firms and their contributions are: Imperial Chemical Industries, Limited, non-ferrous metals, paints and plastics; Stewarts and Lloyds, Limited, steel tubes and fabricated welded structures; United Steel Companies, Limited, structural steelwork and stainless-steel alloys; Williams and Williams, Limited, metal windows, doors and patent glazing; and Taylor Woodrow (Building Exports), Limited, who undertake marketing research, distribution and supervision of erection. The architects are Mr. A. M. Gear, F.R.I.B.A., and Mr. Rodney Thomas, A.R.I.B.A. This wealth of experience gathered together from such an array of independent companies must fairly justify the appellation "unique" which was used by the chairman, Mr. W. F. Lutyens, when speaking at the Group's 100th luncheon recently.

Originally, the Group was concerned with work in connection with the temporary housing schemes operating in the United Kingdom and, by 1946, 41,000 Arcon prefabricated houses had been erected. Research was then begun into the export possibilities of permanent prefabricated houses and the Group's tropical roof—a supported roof to withstand hurricanes, provide insulation from the sun's heat and immunity from attack by insects—now provides a total coverage of about 9¼ million sq. ft. in all parts of the world. Since 1948, other structures have been erected which range from power houses to sheep-shearing sheds, and include amenity buildings as well as housing units. Some of these structures have been described in ENGINEERING. Among the townships largely built by the Group are those at Kuwait on the Persian Gulf and those supplied for Baghdad Fair, the Colombo Plan Exhibition and the Rhodes Centenary Exhibition. From Burma has come an order for a 300-ft. long Buddhist prayer and lecture hall. During recent months—since steel was freed in 1953—many orders have been obtained at home, including one at Derby for a storage building of 27,000 sq. ft. With these results to its credit, the Group believes that it has justified itself by accomplishing more than could have been done by any of its members working in less close association.

BOOK REVIEWS

The Gyroscope Applied. By K. I. T. RICHARDSON. *Hutchinson's Scientific and Technical Publications, Stratford-place, London, W.*1. (30*s*).

This book is based on one published in 1946 under the title *The Gyroscope and its Applications* and follows the same general plan. So much new material has become available in consequence of the partial relaxation of war-time security regulations that it has been virtually transformed into a new work.

Among the earliest scientific applications of the gyroscope was the celebrated experiment, originally carried out, just over 100 years ago by Foucault (to whom the name " gyroscope " is due) to demonstrate the rotation of the earth, and most of us remember the fascination of the gyroscope as a toy of our childhood. More recently a major section of the engineering industry has been developed specialising in the design and manufacture of gyroscopic equipment for both civilian and service purposes. It is with this aspect that Mr. Richardson is chiefly concerned. The use of mathematics is generally avoided, and the appendix, devoted to the " simple mathematics," is hardly adequate for the serious student, who will find it necessary to consult one or other of the standard treatises listed in the bibliography. In the diagram on page 372, the angular momentum of the rotating disc appears to be represented by a vector at right angles to, instead of along, the spin axis.

Gyroscopic motions, being generally three-dimensional, are often more readily embodied in equations than described in words and some discussion of the equations is usually required, in any case, to make plain all their implications. On the whole the author has been conspicuously successful in explaining, in simple language and with a minimum of recourse to symbols, the essential features not only of gyroscopic motions but also of the many intricate mechanisms in which gyroscopes are incorporated. In this he has been greatly helped by the large number of figures, consisting of line diagrams, sectional drawings, block diagrams of complete installations and photographs of typical instruments, mostly with their components clearly labelled.

The text is divided into five sections, the first of which provides a general statement of basic principles (without, however, any explicit mention of nutation), describes experiments with single- and two-frame gyroscopes to demonstrate gyroscopic rigidity and precession, gives illustrations including the precession of the equinoxes, tops, hoops, bicycles, the rifling of gun barrels, and discusses in broad outline the gyroscope in relation to the earth. The statement, on page 15, implying that electrical or pneumatic pressure is the equivalent of energy needs rewording.

The remaining sections are concerned with specific fields of application, beginning with marine applications, among which pride of place is naturally accorded to the gyro compass. After explaining in general terms the construction and operation of gyro compasses, together with means for the automatic correction of latitude, course and speed errors, for minimising friction and overcoming the effects due to the rolling and pitching motion of the ship, separate chapters are devoted to various types of gyro compasses, including the Sperry, Brown, Anschütz and Plath designs. Automatic steering control, as exemplified in the single- and two-unit gear of the Sperry Gyropilot and the Brown automatic helmsman, is considered next, and Section II concludes with an admirable account of the rolling and pitching motions of ships, and their reduction by means of the Sperry gyro stabiliser and the Denny-Brown ship stabiliser (more fully described on pages 489 and 557 of our 170th volume) in which gyro-signals are employed to actuate fins.

Aeronautical applications, dealt with in Section III, make more exacting demands owing to the greater manœuvrability of aircraft and the fact that their speeds so greatly exceed those of ships. Navigational instruments, ranging from the simple directional gyro introduced by Dr. Elmer Sperry in 1913, to the gyrosyn compasses brought out by the same company towards the end of the last war, are considered first, together with alternative types of gyromagnetic compasses developed at the R.A.E., by Kelvin and Hughes and other firms. Gyro vertical and artificial-hroizon instruments are next described, due consideration being given to the effects of turn and acceleration errors. The air drive used in many of the earlier instruments, and adequate for low-level flying, is now being replaced by electrical operation and typical instruments in which the latter is employed are also described. The third gyroscopic instrument encountered on the flight instrument panel of a modern aircraft is the turn and slip indicator and a chapter on this is followed by one on automatic pilots of the two- or three-axis types. Originally installed as far back as 1909, improvements have been such that in 1947, a C47 aircraft of the U.S. Air Force, equipped with a Sperry A12 Gyropilot, took off, flew across the Atlantic, and landed without touching the control column. Particulars are also given of another post-war product, the Sperry Zero Reader Flight Director, which enables the pilot to keep on his correct course by simply maintaining the cross pointer indicator on the centre zero.

Efforts continue to be made to reduce the weight, improve the reliability and increase the accuracy of control of such equipment at ever increasing operational speeds, though details of many of the latest advances cannot yet be published. Among military applications considered in Section IV are included the remarkable mechanisms for weapon sighting used in naval gunnery, the gyroscopic bomb- and gun-sights used in aircraft, the automatic control units embodied in such missiles as the torpedo, the flying bomb and the long-range rocket. The final section deals very briefly with such historical curiosities as the Brennan monorail car, the Schilovsky two-wheel motor car and the more promising gyro-theodolite for underground surveying in coal-mining operations. Mr. Richardson has provided a clear, comprehensive and well illustrated survey of most of the typical instruments and devices in which the gyroscope has come to play an essential role.

Engineering Dynamics. Volume III: Steam Turbines; Volume IV: Internal-Combustion Engines. By C. B. BIEZENO and R. GRAMMEL. *Blackie and Son, Limited,* 17 *Stanhope-street, Glasgow, C.*4. (Volume III, 40*s*.; volume IV, 50*s*.)

The development of the steam turbine and the internal-combustion engine during the last three quarters of a century has given rise to many problems of mechanical design unknown to earlier generations of engineers. The pioneers in these, as in all new fields, had to rely far more on their own genius and intuition than on any help theory could give; for theories, to be trustworthy, have to be confined to the logical explanation of previously ascertained facts, and must therefore tend to lag behind technical advances, however much they may stimulate them. They then have to catch up with practice and formulate the principles involved so as to provide future designers with a sure basis for their work.

This is the object of the present volumes which form part of a series of four. The two others, dealing respectively with the theory of elasticity and its application to machine design are to appear later in the year. The books, competently translated from the original German, are of post-graduate standard and of an advanced mathematical nature. In their preface the authors admit that " the subject matter requires an intense co-operation from the reader," but they have arranged the text to make it as easy as possible for him to refer at once to the particular problem in which he is interested.

The contents of volume III are divided into three main parts, dealing respectively with rotating discs, blading, and the critical speeds of rotors. The first, and longest, discusses the stresses and strains of discs of various shapes under centrifugal force and their possible torsional, radial, and flexional vibrations. Shrinking stresses are also taken into account, and a method of design based on deducing the best form of a disc from the previously assumed permissible stresses is included. The second part deals with blading, and covers the stretching, bending and vibrations of turbine blades under working conditions in both axial and radial-flow machines. The final part is allotted to critical speeds and gyroscopic effects of rotors carrying one or more discs, and takes into account the effect of non-rigid bearings and friction.

Volume IV is similarly divided into three main parts, of which the first deals with the inertia forces of the mechanism of all types of high-speed internal-combustion reciprocating engines. The reactive forces on the bed-plate or other support of the engine are calculated, and various ways of minimising them are discussed. The method of calculation is based on the expression of the forces in Fourier series in terms of the crank-angle, as this is found to be most generally useful, and also facilitates the investigation of resonance. No arrangement of piston engine ever used commercially seems to have been overlooked, each design being treated separately.

The third part, which constitutes nearly half the volume, is devoted to the torsional vibrations due to the elasticity of the crankshaft and the forces arising from the masses connected with it. The method of basing calculations on an idealised equivalent to the shaft is explained, as also is the way of measuring the torsional deformations of an actual shaft erected in its engine, which is obviously more reliable. A full discussion of the natural and forced torsional vibration periods of simple engines, and of engines coupled in series or in parallel, leads naturally to the theory of the automatic vibration absorber known as Taylor's pendulum. This consists of a mass of metal forming a sort of loose counterweight attached to the crank, and serving also to produce automatically a counter-torque that prevents the crank from yielding to dangerous torsional influences.

The books are excellently printed on slightly tinted pages of quarto size, which makes them a pleasure to consult. They are fully indexed, and will be of exceptional value.

Worked Examples in the Theory of Machines. By R. MCVIE. *Hutchinson's Scientific and Technical Publications, Stratford-place, London, W.*1. (12*s*. 6*d*.)

It is generally agreed that the working of problems is essential for the understanding of the fundamentals of engineering science, and nowhere is this more true than in the theory of machines. This book covers the syllabuses of the universities, in that it contains a representative selection of examples which are mostly questions that have been set in examinatons for the degree of B.Sc. in Engineering and for the Higher National Certificate.

The author has gone farther than the mere collection of solutions to 100 problems, and has attempted to summarise the theory involved in some of the principal sections of the work. In this particular, however, the treatment lacks the desirable quality of balance. The theory has been summarised so briefly that it would seem better to omit it altogether, and to substitute a list of references to appropriate chapters in standard text-books. Insufficient attention has been paid to clarity and to discrimination in the choice of methods, with the result that some of the solutions may be confusing to the weaker student who is generally most in need of a book of this kind. The reader should not be left in any doubt as to the assumptions made and the reasons for making them, to questions concerning the units employed in numerical applications of formulæ, or with the task of correcting typographical errors. Other, and more serious, defects would necessitate the correction of errors in the solution of certain examples, especially I, 3; IX, 4 and 8; X, 3; and XI, 7. These are blemishes in a work that would otherwise have made a useful supplement to well-known books on the theory of the subject.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in later issues of ENGINEERING.

A Review of Productivity in the Rigid Boxes and Cartons Industry. *British Productivity Council*, 21 *Tothill-street, London, S.W.*1. (1*s.* 6*d.*) (Reviewed in the issue of February 25, page 227.)

Testing Concrete by an Ultrasonic Pulse Technique. By R. JONES and E. N. GATFIELD. Road Research Technical Paper No. 34. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (2*s.* 6*d.*)

This paper describes the work done at the Road Research Laboratory on the non-destructive testing of concrete. The technique (which is also applicable to soil-cement, rocks, ceramics and wood) uses two transducers placed on opposite faces of a specimen block. Principles are stated and discussed, and methods are elaborated in terms of the numerous investigations made at the Laboratory, the results of which are given in the paper. Properties of concrete that have been examined are the modulus of elasticity, the nature and proportions of the mix including the moisture content, and the variation of these properties with age.

Report on the Collision which occurred on November 17, 1954, at Betley Road between Stafford and Crewe in the London Midland Region, British Railways. Ministry of Transport and Civil Aviation, Railway Accidents. *H.M. Stationery Office, Kingsway, London, W.C.*2. (6*d.*)

In his conclusions Colonel D. McMullen says: "I have no doubt whatever that this accident was the result of the Class 'D' Camden train running past the Wrinehill home signal at Red after it had passed the distant at Yellow . . . Accidents of this nature should be prevented by automatic train control of the warning type. As is known, apparatus of improved design is under trial on the down main line of the East Coast route between New Barnet and Huntingdon. The trials are soon to be extended to both the up and down main lines between King's Cross and Grantham."

Engineering Dimensional Metrology, Vols. I and II. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (45*s.*)

An International Symposium on Engineering Dimensional Metrology was held at the National Physical Laboratory at the end of 1953. The papers presented then and the discussions on them are published in these two volumes. Forty papers were presented covering every aspect of the subject from large to small scale measurements and from workshop inspection to the teaching of the subject at technical colleges.

Expansion or Explosion: A Solution for the Vital Problem of the Machine Age. By ANTONY VICKERS. *The Bodley Head*, 28 *Little Russell-street, London, W.C.*1. (6*s.*)

The author of this book contends that some of the accepted views on production, consumption and money are unsound, and that these errors are highly dangerous. He says that the vital question facing civilisation to-day is: "Should productive capacity be restricted to the purchasing power available, or should purchasing power be expanded so as to permit full production?" He suggests how, in times of peace, nations can use their resources fully and enjoy expansion.

Recommended Domestic Solid Fuel Appliances. List No. 10. Prepared in consultation with the Ministry of Fuel and Power. *Coal Utilisation Council*, 3 *Upper Belgrave-street, London, S.W.*1. (6*d.*)

All the appliances in this list are recommended as being efficient. They are classified according to the specific duties they are required to perform, together with the name of the manufacturer. At the beginning of each section a list of fuels suitable for each type of appliance is given. A separate section is devoted to whole-house warming systems.

Bibliography and Index on Dynamic Pressure Measurement. By W. G. BROMBACHER and T. W. LASHOF. National Bureau of Standards Circular 558. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (75 cents.)

The bibliography is divided into two sections covering books, and papers and reports, respectively. The publications are listed chronologically, and subject and author indexes are included. As well as dynamic pressure measurement, the bibliography covers related subjects, such as static pressure measurement and general information on the components of instruments, in less detail.

Standard X-Ray Diffraction Powder Patterns. By HOWARD E. SWANSON, RUTH K. FUYAT, and GEORGE M. UGRINIC. U.S. National Bureau of Standards Circular 539. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (45 cents.)

The National Bureau of Standards, as part of their programme for revision of published X-ray data for the American Society for Testing Materials card file, presents in this paper, the fourth in a series of standard powder diffraction patterns, data for 5 elements, 35 inorganic compounds, and 2 intermetallic compounds. These patterns are recommended to replace 95 cards now in the file. Seven compounds, gallium oxide, neodymium oxide, strontium chloride, thallium iodide, silver oxynitrate, aluminium antimony, and indium antimony, not represented in the file, have been added.

Conversion Factors and Tables. By O. T. ZIMMERMAN and IRVIN LAVINE. Second edition. *Industrial Research Service, Masonic Building, Dover, New Hampshire, U.S.A.* (5·50 dols.)

In this second edition, certain new material has been added including: an expanded conversion factor section in which all values have been recalculated, based on the latest accepted fundamental values; a section on conversion factors for most of the countries of the world; a section of foreign monetary equivalents; a table of physical constants; and an expanded conversion table section.

Applied X-Rays. By GEORGE L. CLARK. Fourth edition. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (12·50 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (89*s.* 6*d.*)

This book, which was first published in 1927, and the third edition of which appeared 15 years ago, has been greatly enlarged, and thus provides evidence of the growth of applied X-ray science. It is divided into two main parts in the first of which the general physics and applications of X-ray radiation are dealt with, while the second covers the X-ray analysis of the ultimate stuctures of materials. The major advances that have taken place during the last 15 years are described in detail, including the developments that have occurred in X-ray optics and microscopy. Special attention is given to the process of chemical analysis by fluorescence and a chapter on the biological effects of X-rays is included.

Einführung in die Hochspannungstechnik. By MAX WELLAUER. Vol. I of "Lehrbücher der Elektrotechnik." *Verlag-Birkhäuser, Basel/Stuttgart.* (29·65 D.M.)

An advanced theoretical text-book intended for student engineers already familiar with the basic principles of electrotechnology and the elements of differential and integral calculations. This volume is the first of a series intended to form a comprehensive review of the particular field selected for study. Theoretical consideration is given to all branches of high-voltage generation, transformation and transmission, and methods of calculation are shown for all cases to be met with in practice, such as surge phenomena, pulsating voltage, corona effect, etc. The appendix contains 278 references to technical literature.

Vorlesungen über Baustatik. Vol. II: Statisch unbestimmte Systeme. By FRITZ STÜSSI. *Verlag Birkhäuser, Basel/Stuttgart.* (33·30 D.M.)

This book deals with the fundamentals of statics and, in particular, with the consideration of statically indeterminate systems. Methods of calculation based on different principles are explained with formulae and diagrams.

Stanzereitechnik. Vol. I: Schneidende Werkzeuge. By HEINRICH L. HILBERT. Fifth edition. *Carl Hanser Verlag, Leonhard-Eck-Strasse* 7, *Munich* 27, *Germany.* (19.80 D.M.)

This work forms a comprehensive manual dealing with cutting, shearing, punching and pressing operations, of value to the experienced engineer as well as to the trainee. It is based on practical experience and gives useful advice for the planning work, with due consideration to costs. An important portion of the book is devoted to the construction of and calculations for cutting tools, aided by a generous provision of tables facilitating the rapid determination of costs of the successive operations. A comprehensive bibliography gives references to more detailed literature for those wishing to pursue the subject in greater detail. The work includes a list of DIN Standards and AWF Directions relating to the subject, and is illustrated with 350 photographs and diagrams of machines and machine parts, from the smallest detail to crank presses of 800 tons working pressure.

Das wärmetechnische Messwesen in Dampfkraftwerken und Industriebetrieben. By ARTUR KENATH. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.*35. (25.50 D.M.)

This work deals with the instrumental control of modern thermal power stations. It covers the working principles and construction of indicating and recording instruments, and measurements of the efficiency of application of the potential calorific value of the fuel to the final utilisation of heat in the flue gases and condensed steam, as well as the quantitative determination of the water treated and steam produced. The book is illustrated with connection diagrams and photographs of separate control desks and instrument cabinets for feed pumps, preheaters, boilers, turbines, condensers, evaporators, generators and compressors.

Grundzüge der Zerspanungslehre. Vol. I. By MAX KRONENBERG. Fifth edition. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.*35. (48.00 D.M.)

The main object of the first edition of this work was the derivation of scientific cutting laws and their application to the design and operation of machine tools. Increased knowledge and experience has necessitated a complete revision and extension of the work. Cutting speed and cutting force factors and exponents have been established to determine a common denominator for comparison of metal cutting data from industrial countries, thus founding a logical information service. The results of Klopstock's investigations have been combined with Stanton and Heyde's tests to establish formulae for the ratio between rake and cutting force. Cutting force tables, which take into account "size effect," and cutting speed tables have been compiled. The book is divided into two sections, one dealing with basic metal cutting science and the other covering applied metal cutting practice. The problems of negative rakes and stresses in the tool face are discussed.

Praktische Getriebelehre. Vol. II: Die Keilkette. By KURT RAUH. Second edition. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.*35. (43·50 D.M.)

This work deals with mechanical movements for the transmission and change of direction of force derived from the simple wedge movement. The appendix contains 886 illustrations of applications to various machines.

Die Tragfähigkeit der Zahnräder: Neuzeitliche Berechnungsweise der Zahnbeanspruchungen von Stirn-, Kegel-, Schnecken- und Schraubenrädern. By A. K. THOMAS. *Carl Hanser Verlag, Leonhard-Eck-Strasse* 7, *Munich* 27. (14·80 D.M.)

This work deals exhaustively with the basic principles for the calculation of the strength of gears and gear trains. Consideration is given to geometric calculations, design and construction, lubrication and cooling. The formulae are clearly explained in the text and by drawings, with many examples of calculations taken from practice.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electric Motors. LANCASHIRE DYNAMO AND CRYPTO LTD., St. Stephens House, Victoria Embankment, London, S.W.1. Outputs and dimensions of new standard range of squirrel cage motors of the protected and fan-cooled types for three-phase 50-cycle supplies up to 650 volts. Complete interchangeability with American and Canadian motors. Illustrated leaflet.

Fire Protection Products. GYPROC PRODUCTS LTD., Upper Singlewell Road, Gravesend, Kent. Fire tests for building materials, fire protective properties of Gyproc products, including wallboards, lath, and plasters; fire resistance gradings of various Gyproc products incorporated in structures. Illustrated booklet, Section K of "The Gyproc Book," 1954–55 edition.

Hydraulic Turbines. BALDWIN LIMA-HAMILTON CORPORATION, Philadelphia, 42, Pennsylvania, U.S.A. Francis, Pelton steel, fixed and adjustable blade turbines and associated equipment for hydro-electric projects. Technical details of recent installations. Data for assisting the selection of

speeds and sizes for given conditions of head, horse-power or discharge. Fully illustrated booklet.

Roof Preservatives. INDUSTRIAL ENGINEERING LTD., Mellier House, Albemarle-street, London, W.1. "Flexicol," bitumen-proof dressing, able to cover any bituminous surface (creosote, tar, roofing felt, protected-metal sheets, etc.) in colour. Brush or spray application, single-coat only required. Leaflet and sample.

Photocopying. GRANT PRODUCTION CO., LTD., 4 Rathbone-place, Oxford-street, London, W.1. Makers of photographic apparatus for reproduction of drawings, documents, photographs, etc.: copiers, projectors and printing machines. Illustrated booklet.

Lighting Switches. J. A. CRABTREE & CO., LTD., Lincoln Works, Walsall, Staffordshire. Flush and surface mounting switches and sockets for lighting and domestic power circuits. Also terminal boxes, roses and lamp holders. Illustrated pamphlet No. 1167.

Electricity in the Home. BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION, 2 Savoy-hill, London, W.C.2. *Electricity—a Power of Good.* Booklet describing methods of installing electrical apparatus in new and converted houses, including plans of some schemes. Publication No. 1768.

Mobile Hoist. WICKHAM ENGINEERING CO., LTD., 215–218 Dashwood House, Old Broad-street, London, E.C.2. Mobile hoist, electric, petrol or Diesel driven, lifting capacity 5 cwt., weight 9 cwt. Mast height 20 ft. self supported or 50 ft. supported. Illustrated leaflet.

Turret Jaw Vice. W. H. COLT (ENGINEERS) LTD., 312 Grand Buildings, Trafalgar-square, London, W.C.2. Vice with rotatable turret jaw offering several different gripping surfaces for round, square or taper work. Bench and machine models. Illustrated leaflets.

Electronic Controller for Power Circuits. BATES & BATES LTD., 73 Ashville-avenue, Birmingham, 34. Type 50-1 electronic power-controller for both switching and regulating. Two sizes for 6·8 amp. or 14 amp. at both 240 and 440 volts. Leaflet gives details.

Nylon Yarns. BRITISH NYLON SPINNERS LTD., Pontypool, Monmouthshire. Uses of nylon yarns in varied fields, including fuel tanks, ropes, nets, hoses, containers, boiler suits, parachutes, crash helmets, etc. Illustrated booklet, entitled "Nylon goes to work."

Key-less Pulley. THE ZERNY ENGINEERING CO., LTD., Rickmansworth, Hertfordshire. "Dualok" key-less pulleys with twin flexible cones contained in the hubs; instructions for fitting and removal; dimensions of bushes and pulleys available. Illustrated pamphlet.

Protective Screens. THE COLEMAN-WALLWORK CO., LTD., Slotfold, Arlesey, Bedfordshire. Screens for use in iron and steel works to prevent injuries from flying molten fragments; constructed from sheet steel and close steel mesh, mounted on castors. Illustrated leaflet.

Engines for Diesel-electric Locomotives. SULZER BROTHERS (LONDON), LTD., 31 Bedford-square, London, W.C.1. Twin-bank supercharged Diesel engines for locomotives. 12 cylinders developing 2,000 h.p. at 710 r.p.m. as used on French railways. Descriptive leaflet.

B.G.M.A. Buyers' Guide. BRITISH GEAR MANUFACTURERS' ASSOCIATION, P.O. Box 121, 301 Glossop-road, Sheffield, 10. Catalogue of B.G.M.A. member-firms together with their products and services. Booklet.

Limit Switches. J. A. CRABTREE & CO., LTD., Lincoln Works, Walsall. Alternating current snap and slow action limit switches for 600-volt, 2-ampere circuits. Details of design, construction and operation. Illustrated brochure.

Control Gear for Pumping Plant. ALLEN WEST & CO., LTD., Brighton, 7. Control and switchgear for pumping stations, sewage plants, etc., including circuit breakers, starters, sequence-controllers and accessories. Illustrated booklet.

Brass and Copper Tube and Fittings. C. RYAN & CO., LTD., 2-20 Capper-street, Tottenham Court-road, London, W.C.1. Brass and copper tube, tees, elbows, bending springs and other accessories. Leaflet.

Fittings for Compressed Air Lines. B.E.N. PATENTS LTD., High Wycombe, Buckinghamshire. Cocks, gauges, clips, unions, separators and reducing valves for compressed air lines. Catalogue CB 111.

Workshop Furniture. METAL INDUSTRIES LTD., 60 Buckingham Palace-road, London, S.W.1. Fawcett Preston's "Steelpact" benches, lockers and tool stands. Leaflet PM/FP/1.

DEVELOPING CANADA'S RESOURCES

WATER POWER, MINERALS, PETROLEUM AND NATURAL GAS

The preceding article on Canada, on page 527 of last week's issue of ENGINEERING, stressed the importance of British participation in Canadian development as a means of increasing British exports in this expanding market. Such participation does not necessarily mean investment in the exploitation of Canadian natural resources; manufacturing industry is also expanding rapidly, and the resultant demand for plant and machinery provides perhaps the most favourable opportunity of all for British exports to Canada. A number of British companies whose products range from textiles to aircraft already have important interests in Canadian manufacturing industry. These include Imperial Chemical Industries, Limited, who are building a Terylene plant at Millhaven, Ontario; Tate and Lyle, Limited; British Insulated Callender's Cables, Limited; R. W. Crabtree and Sons, Limited, the printing machinery manufacturers; and Millspaugh Limited, manufacturers of papermaking machinery. Financial difficulties will, of course, severely limit British investment in the development of Canadian natural resources, and Canadian official restrictions, as well as British, have meant the loss of some valuable investment opportunities for British capital.

Under the agreement for the repayment of the Canadian loan to the United Kingdom in 1942, British investment in Canada has been permitted by the Canadian Government only if it could "contribute to Canadian industrial development." The interpretation of this clause excluded the possibility of British participation in any projects for the exploitation of natural resources which the Canadian Government considered speculative, at a time when important possibilities were opening up. In consequence, the British stake in Canadian petroleum and mineral development is limited largely to the participation of the Hudson Bay Company. Nevertheless, the volume of British investment in Canada has grown considerably in the past few years, and some of it is in "resources" industries. British finance houses, investment trusts and large industrial enterprises have formed joint organisations to enable investment to be canalised into the most effective channels. The British Newfoundland Corporation, for example, a syndicate of various British and Canadian interests, is surveying the prospects for developing the water power of the Grand Falls area on the Hamilton River in Labrador. Preliminary reports indicate a potential capacity of 3 million h.p. As a first stage, a 1 million h.p. plant at a cost of between 150 and 250 million dols. may be completed by 1962.

HYDRO-ELECTRIC PROJECTS

The twin keystones of Canadian development are the rich mineral and cheap power resources. Industrial, and to a large extent, mineral development, would be extremely difficult without the enormous water power. This is fortunately well distributed throughout the country, although in Alberta it is remote from the present centre of population, and Saskatchewan relies mainly on steam generation. Ontario and Quebec, the most industrialised provinces, have very little indigenous coal, but they account for nearly four-fifths of the Canadian developed water power resources of about 16 million h.p. and for well over half of the estimated total potential power of 71 million h.p.

Turbine capacity is at present increasing at the rate of about 1 million h.p. per annum and many of the most important schemes are just beginning. The most spectacular are those in British Columbia, on the Yukon, and the St. Lawrence Seaway, but considerable development is taking place elsewhere. The Government of Manitoba, for example, are considering the building of a plant of 300,000 h.p. at Grand Rapids, 26 miles north-west of Winnipeg, at a cost of 90 million dols. In New Brunswick, work has started on the Beechwood project (costing 45 million dols.) on the St. John River. This is the first of three plants which will give 374,000 h.p. and eventually it is hoped that a potential capacity of 720,000 h.p. in the area will be realised. A project for the harnessing of Niagara Falls will actually yield more power for Ontario than the Canadian share of the development on the St. Lawrence Seaway. The whole installation, which will have a capacity of 1·2 million h.p., should be complete by 1956.

THE ST. LAWRENCE SEAWAY

The St. Lawrence Seaway project, upon which work finally started last August, will enable 2·2 million h.p. of hydro-electric power to be developed from International Rapids, the western stretch of the reach of the St. Lawrence from Montreal to Prescott. Half of this will go to the United States. As a result of the Seaway scheme, however, it will be possible for the Quebec Authorities to increase power production at Beauharnois, already one of the largest hydro-electric power stations in the world, to 2 million h.p., and to develop an extra 1·2 million h.p. in the Lachine section of the river. The navigational gains to be achieved from the Seaway are extremely important. Although a continuous waterway already exists for 2,200 miles from the Atlantic Ocean to the head of Lake Superior, the stretch of 114 miles between Montreal and Prescott (Ontario), with a draught of only 14 ft. and with six canals, prevents the access of ocean freighters to the Great Lakes. The new seaway, the date of completion of which is tentatively set for the end of 1958, will have a minimum depth of 27 ft., and should be carrying a traffic of perhaps 25 to 30 million tons a year each way in 1959.

A westbound volume of this magnitude seems assured by the carriage of iron ore from the new Labrador fields to the blast-furnaces in the United States. This alone is estimated at 20 million tons and there will also be other bulk cargoes including coal, paper and timber. The first commercial shipment of iron ore from Labrador was made last year—by sea to Philadelphia, and this year it is expected to ship 10 million tons, partly by sea and partly by the existing St. Lawrence waterway. This iron-ore project, which has taken 12 years and an outlay of 250 million dols. to bring into production, has been one of the largest of the Canadian mineral development schemes. The exploitation of the reserves in the Knob Lake region, which are estimated to contain 417 million tons of ore with an iron content of 55 to 65 per cent., has required the construction of a 360-mile long railway.

Some of the most striking of the Canadian hydro-electric schemes are in the extreme West. The British Columbian Government has announced plans involving an outlay of 1,860 million dols. for developing the resources of the Fraser, Yukon and North Thomson river systems. Of all the large hydro-electric projects of recent years, none has been more remarkable than the Nechako-Kitimat scheme of the Aluminum Company of Canada which has necessitated the diversion of the headwaters of the Fraser river by a 10-mile long tunnel through a mountain range to an underground power station. The first stage of this scheme giving 420,000 h.p., together with the associated smelter with an annual capacity of 91,500 tons, was completed last August. The construction of a further 60,000 tons capacity was authorised last October and more recently a plan was approved for extending it to 330,000 tons per annum by the end of 1959. Eventually, it should be possible to achieve an output of 550,000 tons of alumi-

nium from a hydro-electric capacity of 2·24 million h.p. Expansion to this extent, however, will depend upon the future course of world demand. The British Government made a loan of 120·5 million dols. for the first part of the project, and generating equipment, transformers and cables were supplied by British companies. The cost of the recently announced expansion programme is 190 million dols. Raw material for the smelter will come mainly from the alumina plant at Kirkvine in Jamaica, although some is also being imported from Japan. Expansion of the Jamaican plant to meet the increased requirements of Kitimat will require an expansion programme costing £4 million.

MINERALS IN THE YUKON

A project as impressive as Kitimat is that of Quebec Metallurgical Industries and Frobisher. At a cost of 1,000 million dols. this company propose to harness the power from a watershed in the Yukon holding a potential of 5 million h.p. and transmit it southward to British Columbia, where it will be used to smelt or refine various mineral ores and concentrates, both local and imported from many parts of the world. The intention is to form large reservoirs near Whitehorse, at the confluence of the Yukon and Big Salmon rivers, and 40 miles north of Teslin Lake. Water will be carried through mountain tunnels to power plants to be built in the Sloko, Nakonake and Taku river valleys. Power will be transmitted to the site for the production plants which will probably be about 20 miles up the Taku river on the Alaskan border.

The production plants will at first, concentrate on the nickel, cobalt, iron, steel and manganese alloys. Nickel-cobalt ores from New Caledonia and the Phillipines, as well as from local sources, can be conveniently used to obtain an output of 3·7 million lb. of cobalt and 80·5 million lb. of nickel by 1962. Sufficient Pacific coast iron ores are available for a production of 210,000 tons per annum by 1962, and with ferro-manganese and silico-manganese from South-West African ores it is expected to achieve an annual output of 160,000 tons of manganese alloys. Zinc and other non-ferrous metals will also be obtained from local Canadian concentrates. The Yukon is second to no other area in the world for richness and variety of mineral resources. Nickel, tungsten, molybdenum and cobalt silver, copper zinc, palladium, mercury, tin bismuth, barium, thorium and petroleum all occur as well as very extensive reserves of iron ore. The project of the Frobisher company is the first step in opening up this very extensive treasure house.

COMPETITION FROM ATOMIC POWER

For all its cheapness, Canadian hydro-electric power may have a serious competitor in nuclear energy within a few years. A Canadian scientist recently forecast that atomic power plants would be producing electricity economically in Canada between 1960 and 1965. Plans have already been approved for a small pilot plant of 20 MW capacity. It is true that this will not be able to supply electricity competitively, but it should provide useful experience for the design of economic 100-MW reactors. Canada is well placed for uranium supplies with ore-fields in the North-West Territories, Saskatchewan and Ontario. Output by 1957 may be worth 100 million dols. a year. Algom uranium mines just north of Lake Huron will eventually be able to produce 3,000 tons of ore a day; the Pronto uranium mines in the same area should be producing 1,000 tons a day by September. The Beaverlodge fields in Northern Saskatchewan should shortly be capable of an output in excess of 2,000 tons a day. The fields at Port Radium on the Great Bear Lake have been producing for a long time and are still in production although the importance of the area has diminished with the discoveries in Ontario and Saskatchewan.

PRAIRIE PETROLEUM

Capital expenditure on the development of the extensive oil reserves in the prairie provinces (estimated at 2,250 million barrels) has grown rapidly. The 24-in. Trans-Mountain pipeline from Edmonton to Vancouver, and the extension in eastern Canada of the Inter-Provincial pipeline from Lake Superior to Sarnia have opened up considerable markets for this oil, both in Canada and the United States. In 1954 production of crude oil, running at a rate of about 270,000 barrels a day, 20 per cent. more than in 1953, supplied about half the total Canadian demand. The potential production of the wells is at present about 390,000 barrels a day, but the realisation of this output will require heavy outlay on refineries and facilities for bringing the oil to the large markets. A total outlay of 600 million dols. is planned for 1955—slightly more than for 1954. This is to include, in addition to the expenditure on prospecting and development, an extension of one-sixth in refinery capacity and an outlay of about 100 million dols. on pipelines and transportation. The pipelines are now reaching down to the United States: an extension of the Trans-Mountain pipeline was built in 1954 to Ferndale, Washington, to serve a refinery, and a subsidiary line of the Inter-Provincial pipeline has been built to permit the delivery of medium gravity crude oil from Saskatchewan to a refinery in Minneapolis. Sales to the United States are expected to amount to at least 65,000 barrels a day in 1955 when total Canadian crude oil production should rise to 338,000 barrels a day.

The development of the natural gas resources of Alberta is hampered even more than those of oil by the problem of transport to distant markets. A project for a 2,200-mile pipeline to Toronto and Montreal costing 350 million dols. has had to be postponed for a year through the inability of the Trans-Canada Pipe-Line Company to raise the capital quickly enough for a start to be made this spring. Nevertheless, the natural gas, which will probably also sell in Minnesota, should make an important contribution to the Canadian economy.

OPPORTUNITIES FOR CONTRACTORS

All these projects for developing natural resources are giving rise to increased demand for plant and equipment both directly and indirectly through the growth of associated manufacturing industry; but, above all, they are creating a volume of construction and civil engineering activity which will strain the resources of even the large Canadian contracting industry. United States contractors are, of course, very active in Canada but there should be plenty of opportunities for British contractors. At least 16 have now established themselves in Canada and have already shown themselves capable of tackling work in difficult climates as effectively as their American competitors. The latter, with years of experience in such conditions and with large comprehensive organisations, have many advantages. In consequence, British manufacturers have not found it too easy to sell themselves to Canadians, but the volume of work obtained by them or their Canadian subsidiaries (which include some established Canadian companies, acquired as a convenient means of entering the market) is already impressive. The largest contract, that held by John Laing and Son, for the development of Annacis Island Industrial Trading Estate, may eventually involve an expenditure of over £100 million. With British contractors should come opportunities for British plant, which may then establish itself on its own merits with Canadian contractors. All round, the outlook for British interests in the Canadian market is promising. With all its opportunities, however, it remains a difficult market and there is much uphill work to be done if the value of British exports to Canada is ever to match the value of British imports from Canada.

Institution of Naval Architects Spring Meeting (*continued from page* 497)

A CENTURY OF LLOYD'S RULES

The third paper in the programme of the 1955 Spring Meeting of the Institution of Naval Architects, held in the Institution's newly-completed Weir Hall at 10 Upper Belgrave-street, London, S.W.1, was delivered on April 5 by Mr. J. M. Murray, M.B.E., B.Sc., and was entitled " A Hundred Years of Lloyd's Register Ship Rules." The chair was taken by Mr. R. B. Shepheard, C.B.E., B.Sc., the Chairman of Council of the Institution.

IRON AND STEEL IN SHIPBUILDING

Lloyd's Register (" of British and Foreign Shipping," subsequently shortened to " Lloyd's Register of Shipping ") introduced their first Rules for the scantlings of iron ships on April 12, 1855, as the result of representations made to the Committee by Messrs. Alexander Stephen and Sons some two years previously. There were references in the Register Book to ships built of iron as far back as 1836—only two years after the Society was reconstituted in its present form —and in 1843 it had been decided that iron ships could be classed A1, subject to annual survey. Information on current practice was gathered from leading shipbuilders and a tentative set of Rules for minimum dimensions was drawn up and circulated to the industry. They were favourably received except for a few objections (some of which came from Messrs. Stephen, who had initiated the new departure) and, as stated, they were issued officially on April 12, 1855, under the title of " Rules for the Building of Seagoing Iron Ships of All Descriptions whether Sailing or Navigated by Steam." They were based on the gross tonnage of the ship, as was the practice with wooden vessels at that time, and scantlings were given for classifications of 12, nine or six years; this practice, however, lasted only until 1863. Instead of it, special notations were introduced to indicate differences in construction as regards thickness of plating, strength, and probable durability. The Rules were revised again in 1870, the tonnage basis being dropped and the scantlings determined by the ships' dimensions.

With the introduction of steel as a shipbuilding material, the importance of iron rapidly declined until, by 1895, only 1 per cent. of the tonnage built in Great Britain was of iron; but it was not until 1888 that the Society brought out a complete set of Rules for Steel Ships. Thereafter, both the Iron and the Steel Rules were printed until, in 1894, the Iron Rules were dropped. In 1909 the Steel Rules, which had been adopted when Benjamin Martell was Chief Ship Surveyor, were revised by Mr. Harry J. Cornish, who then held that office; these Rules took account of the proportions of ships, and included a section for vessels intended to carry oil in bulk. After the 1914-18 War there was another complete revision, which set a standard of strength that was accepted as reasonable for nearly 40 years. Modifications were made in 1922 and again in 1924 in matters of detail. The most recent revision, to take account of welding and other developments, was issued in 1949.

DISCUSSION : THEORETICAL PRINCIPLES AND SERVICE EXPERIENCE

Mr. J. Hodgson, who opened the discussion, pointed out that compliance with Lloyd's Rules was entirely voluntary and that the Rules were actually controlled by a voluntary association of different sections of the whole shipping industry —some of which, of course, might have conflicting interests; that was a British idea which had been widely copied throughout the world. The Rules laid down minimum standards of strength which were universally acceptable, being based on the widest experience and available knowledge; the

standards had to be strictly uniform and impartial and, above all, the Rules must inspire general confidence. He thought that the 100 years' history provided sufficient evidence on that point. It would not be difficult, with the much greater experience of to-day, to criticise the early Rules, when their provisions apparently lagged well behind technical progress; but the early architects of the Rules, of necessity, had to move forward cautiously, sometimes by trial and error. Even to-day, with much greater knowledge and experience, it was frequently necessary to do the same, when progress demanded new and untried types and methods of construction. Theoretical principles had played a much greater part in the preparation of the present Rules, but service experience must still remain the important factor on which the Rules were based and amended.

Mr. Murray had mentioned that Lloyd's Register had a very elaborate recording system for service behaviour, whereby information was quickly analysed and readily made available. Those records frequently disclosed problems requiring urgent solution and indicated lines of profitable research. He paid tribute to the various research bodies, particularly the British Shipbuilding Research Association, which had collaborated so closely with Lloyd's Register in tackling important structural problems disclosed by the service records. That collaboration was particularly essential at the present day, when they were more or less in a transition stage, and were faced with several complex problems peculiar to modern ships; for example, the brittle failure of steel—really a very old problem.

SPEED AND CARGO DISTRIBUTION

As the paper indicated, a considerable number of years elapsed before steel was considered entirely satisfactory for riveted ships. To-day, they were going through a somewhat similar phase in respect of the suitability of steel for all-welded ships. Adequate solutions would be found only by energetic co-operative effort and by realistic and objective thinking, and, probably, some further research. Another modern problem with which Lloyd's Register had been concerned was the post-war development in the modern high-speed cargo ship. As Mr. Murray had explained, it was no longer possible to prescribe a uniform standard of strength applicable to all types of cargo ships on the basis of dimensions only; standard load distribution and speed had to be introduced as a basis for correction factors. The amendments made were based on sound technical principles, conditioned by the analysis of the service behaviour of very many modern ships. A further point with regard to the high-speed modern cargo ship was that, whereas all ships required careful handling in heavy weather, ships of high power and speed needed it in particular.

Mr. J. Lenaghan thought that an excellent pictorial reference to associate with the paper was Campbell Holms's treatise *Practical Shipbuilding*; Vol.2, with its diagrams and illustrations, showed details of the structural design of ships typical of a period 50 years ago. Perhaps the most striking feature, from a quick glance at some of the midship sections, was the change that had taken place in framing. Campbell Holms came in about 50 years ago and it was rather a pity that his treatise had been allowed to lapse.

The modern ship, and particularly ships built within the past decade, presented many new problems, but recent changes in Rules would go a long way towards taking care of them. The attention now given to the disposition of the cargo spaces, and the introduction of a speed factor, were without doubt in the right direction. He felt, however, that there were dangers, perhaps more psychological than physical, in providing too many safeguards with the intention of avoiding faults in design. Rules provided for uniformity, but they could encourage a degree of single-mindedness, and cramming too much into the Rules might lead design staffs to overlook the advantages to be obtained in working out special cases for themselves. The war-time standard cargo liner referred to in the paper might have had a good record as the result of a low total stress. The disposition of the engine space in those ships was not determined through consideration of stress values, but rather by a request from the operators to ensure that there would be three good hatches forward and two aft of the main superstructure. One good feature encouraged by the Rules was the importance of structural continuity, particularly in longitudinal members. He had been much impressed by that feature in naval designs; it gave the structure a sound and homogeneous look throughout, which designers on the merchant side could follow with advantage.

LLOYD'S REGISTER AND THE BRITISH CORPORATION

Professor A. M. Robb said that he could recall the days when "the British Corporation allowed us to do certain things, but Lloyd's would not." That was the sort of background against which he viewed the paper. He would like to see Mr. James Turnbull discuss 100 years of Lloyd's Register of Shipping Rules from the point of view of the British Corporation; because he was intrigued by the incompleteness of the history given on the first page of Mr. Murray's paper. There was a reference to Alexander Stephen and Sons, in 1853, and, later on, there was a reference to their objections. The founding of the British Corporation was an attempt, as all would know, to get away from the "tyranny" of Lloyd's Register. He stressed the point made by Mr. Murray, when he referred to the three agencies, experience, experiment and calculation, that, of those three factors, experience was the most important. He would like to think that theoretical knowledge was good enough to enable them to design things from first principles; but it would be a long time before that point was reached.

Mr. James Turnbull, O.B.E., replied to Professor Robb that he still had the mantle of the British Corporation and also another mantle, that of Lloyd's Register. He had not shed either, because there was a uniting of the two societies, not an absorption. Looking back, it was easy to see the flaws in the basis for scantlings. Who could imagine anyone would consider that gross tonnage was a suitable basis for the scantlings of a ship? Later they came on to numerals which were based on most unscientific grounds; but that unscientific basis was put into the Rules by men who had first-class knowledge of the then modern scientific information. Could Mr. Murray throw some light on that enigma? That was difficult to-day, when the Rules were undoubtedly up to date and in line with modern knowledge and experience; indeed, he thought that they were slightly ahead of it.

REDUCTION IN HULL WEIGHT

Would the generations of the future think of present-day Rule-makers as simple souls who could not find the obvious answers to the problems that we had with all-welded ships, quite apart from riveted ships? He thought that the most outstanding achievement in the period under consideration was the tremendous saving in hull weight. How many owners realised that, in that period, the weight of the hull had been reduced by as much as 50 per cent., and that it had been effected in conjunction with other benefits? There had been a removal of web frames and side stringers, and a reduction of the number of pillars, etc., resulting in very clear holds. While that evolution had not been as spectacular as those in other scientific fields, it had had a tremendously favourable influence on the earning capacity of a ship.

Professor S. J. Palmer, O.B.E., suggested that the author's Fig. 2 might give the impression that the calculated stresses should follow the rather odd composite curve at the top of the graph. He assumed that bending moments had been calculated for the 450-ft. ship with the gross tonnage kept constant by extending the superstructure at the ends, and that then, with the assumption that the modulus was directly related to the beam and draught, the calculated stresses were as shown in full lines. Above $\frac{V}{\sqrt{L}} = 0{\cdot}75$, because, presumably, of slamming and other hydrodynamic forces which would increase with speed, the maximum calculated stresses that Lloyd's were prepared to accept were shown by the dotted line. He asked the author to confirm that he was not suggesting that the allowable stress should follow the limits given by the full curve up to $\frac{V}{\sqrt{L}} = 0{\cdot}75$ and by the dotted line at speeds above that. It would be illogical to work to lower stresses in a ship whose $\frac{V}{\sqrt{L}}$ was 0·6 than those accepted for a ship whose $\frac{V}{\sqrt{L}}$ was 0·75, though that was what appeared to be implied.

Mr. B. N. Baxter, M.Sc., referring to the author's statement that it was the practice to send surveyors to sea to observe the structural behaviour of ships, asked whether those observations included the measurements of hull strains and deflections. The use of a statistical strain gauge, of the type used on the "Ocean Vulcan" trials, would be very advantageous in that connection. Was any research work being done on the questions of hull or local vibration? In the conclusions, the author suggested that there might have been occasions on which the Rules lagged behind progress. He had, however, given an example in the paper, showing how far they looked ahead.

Appendix IV showed that the average speed of dry-cargo ships had increased by 1½ knots in 25 years, representing an increase from 0·612 to 0·683 in the $\frac{V}{\sqrt{L}}$ value for a 450-ft. ship. In Fig. 2, the curve of total stress was plotted on a base of $\frac{V}{\sqrt{L}}$ varying from 0·60 to 0·90, i.e., speeds of 12·73 to 19·09 knots. If the rate of increase in average speed remained constant, that diagram would still be useful for nearly another 100 years.

NON-DESTRUCTIVE EXAMINATION

Mr. C. C. Bates said that, while appreciating the necessity for the author to make only limited reference to many of the "so-called off-shoots of Lloyd's Rules," he felt there was one that must be mentioned, namely, non-destructive examination, with which, in respect of welding, he was intimately concerned. The author reported that the Rules laid down fairly detailed regulations regarding workmanship and procedures, but went on to say that they were dependent upon conscientious workmanship and thorough supervision. Without having one inspector per welder, such "thorough supervision" was impracticable. So far as he was aware, while Lloyd's Register welcomed non-destructive examination, such as by radiography, their Rules did not make it mandatory. Again, while they had a system of approving constructors' radiographers and of sending some of their own surveyors to a course on radiography, unless the non-destructive examination was done by a specialist of an independent organisation, and the interpretation was done by personnel who were doing it all day and every day, the full advantage of any non-destructive examination was not gained. Haphazard and semi-uncontrolled spot checking as a means of quality control was not economic and did not serve its full purpose.

Ships were frequently docked, overhauled and surveyed; surely, Mr. Bates said, if some measure of non-destructive examination at highly stressed zones were instituted during those survey periods, it might be possible to catch and repair small cracks before they propagated into major catastrophes? The limited costs of such a non-destructive examination would be adequately

offset by the possible failures they might prevent. It was interesting to note that Alexander Stephen was one of the instigators, though virtually a reluctant acceptor, of Lloyd's Rules. It appeared that the same company were still in the van of progress, for one of their directors was a founder member of the Society of Non-Destructive Examination, and had stressed the urgent necessity for a controlled and economic system for radiography in shipyards.

Mr. K. C. Barnaby, in a written contribution, said that Mr. Murray had produced a fascinating account of the early history of Lloyd's Register, but all designers of fast ships should join issue with him on one point, namely, the assumption that speed necessarily increased the bending stresses. Taking a suitable block coefficient for the speed/length ratio, such as that indicated by the well-known Alexander formula, and plotting on a base of descending coefficients, they obtained a curve precisely similar to the author's Fig. 2. It seemed more correct to plot the results of a purely static calculation on a static and not on a dynamic base. Against this, it might be argued that Mr. E. L. Champness showed in his 1922 paper that block coefficient had practically no effect on bending moments as measured by the conventional approximation of displacement multiplied by length and divided by 35. Why that difference between 1922 and 1955? The most acceptable reasons seemed to be that modern tank research had led to fuller midship sections and finer ends on fast ships, thus concentrating buoyancy amidships and increasing the hogging moment; and that relatively light crew spaces had been moved from forecastle and poop to amidships and the vacated spaces utilised for heavier cargo.

The revised Lloyd's rules catered adequately for heavy weights on fine ends, though the revision was, perhaps, a little overdue; as long ago as 1866, Mr. John Grantham called the attention of the Institution to what he termed " the pernicious practice by which all Science is set at naught of unduly loading the ends of long and fine ships." So the mills of Lloyd's Register did seem to have ground a little slowly. As regards the concentration of buoyancy amidships, a true criterion would be the difference of the buoyancy and weight moments in either the fore or aft bodies about the longitudinal centre of buoyancy. That ought to include both hull and cargo weight, so it would be difficult to devise a simple formula to measure the difference. In lieu, Lloyd's Register had adopted the highly undesirable expedient of putting a penalty on speed; that masked the real trouble and drew a red herring across the trail. It imposed an arbitrary and empiric penalty that might or might not be needed.

Professor E. V. Telfer thought that Mr. Murray had not lost many opportunities of turning the past critics of Lloyd's Register into probably its strongest defenders; for example, he actually suggested that John Scott Russell was a defender of Lloyd's Register. His remarks at one time might have made it appear like that; but if there was ever a critic of Lloyd's Register, it was John Scott Russell. He was called upon by Mr. Murray as a defender of Lloyd's Register because he was supposed to have said that the "Annette," a longitudinally-framed ship, was built to show that Lloyd's were amenable to argument and that they would accept alternative arrangements. They did allow the knowledge and real wisdom of some of the leaders of the profession, throughout the period of their existence, to leave an impact on their own Regulations; an excellent mechanism and one to be encouraged.

LONG-LIVED IRON SHIPS

Mr. C. V. Manley referred to the author's statement that the use of iron for shipbuilding did not last for a very long period. Actually, it began in the 1830's and it extended into the Twentieth Century. The Iron Ship Rules were not re-issued after 1894, but ships continued to be built to those Rules. From 1894 to 1911 there were 595 iron ships built to Lloyd's Register class, and there was still a small amount of iron shipbuilding at the end of World War I. The extent to which it lingered on, in spite of the superior qualities of steel, gave the impression that iron possessed some essential virtue as a shipbuilding material, if only for small craft. As a pointer, there were in the current Register Book 362 iron ships, of 127,500 tons gross—small craft still in existence and operating. Included among them was one built in 1840, the "Hsintai," 168 ft. long and 480 tons gross, now under the Chinese flag. That ship was 115 years old and is still doing her job. He wondered whether it would ever be possible to say the same about a steel ship. The author referred to the introduction in 1870 of the 100A class, which was associated with the lower grades 90A, 80A, etc., long since discontinued. There was still one ship in the Register Book, holding the classification of 90A1. She was of iron, built in 1877 at North Shields, and was named "Lizzie & Annie". The author concluded that the problems which beset the present generation were in essentials the same as those which troubled their forefathers. There was no more striking instance of that than the fact that, in 1868, they were studying brittle fracture.

AUTHOR'S REPLY

Mr. Murray, replying to the discussion, said that Professor Palmer had made a very important point. The full line in Fig. 2 might be called the natural stress for the ship. In other words, with a ship with a $\frac{V}{\sqrt{L}}$ of about 0·60, in the homogeneous condition the natural stress was about 8·2 tons per square inch. A $\frac{V}{\sqrt{L}}$ of 0·80 represented a different ship altogether, probably with a long poop and a long forecastle.

As long as there was competition in classification there was bound to be a lowering of standards, and the fusion of the British Corporation and Lloyd's Register was one of the best things that ever happened for British shipbuilders from the point of view of safety. The problem of non-destructive examination was mentioned by Mr. Bates. In about three months time there would be an alteration in the Rules which would more or less meet his point.

Mr. Lenaghan might not have known that Campbell Holms was a Lloyd's surveyor, but he made an important point when he said that not enough calculations were done in shipyards. Lloyd's Register would welcome the shipyards doing more calculations.

He agreed very much with Mr. Turnbull in many of his remarks and was inclined to think that, as he suggested, the limit had probably been reached as regards making general Rules; more and more, in the future, the emphasis would be on the specific case. It took a great deal of determination on the part of the then Chief Ship Surveyor in 1870 to get rid of gross tonnage as a parameter; the shipbuilder thought that gross tonnage was an excellent thing and was quite enough to determine the scantlings of any ship. When it was suggested that Lloyd's Register might be a little slow and cautious in making changes, it must be remembered that shipbuilders were not always receptive of new ideas.

Mr. Manley said that iron ships lasted longer than steel ships, but he would not go into that question. The reference to the Hsintai was interesting. It was known that she was built in 1840 and was still on the Register, but they did not know when she was last surveyed. He wondered whether, in fact, she was still operating. There was another very old ship, reputed to be the oldest still in the Register Book, but they had an idea that she was probably a tug of the same name as the ship in question.

(*To be continued*)

Institute of Metals Spring Meeting (*concluded from page* 530)

URANIUM ALLOYS, TWINNING, AND THE DEFORMATION OF ZINC

Continuing our report of the recent Spring meeting of the Institute of Metals in London, we have now to deal with the proceedings at the technical sessions of programme " B," held on the morning and afternoon of Thursday, March 31.

CONSTITUTION OF URANIUM ALLOYS

The whole of the morning was devoted to a consideration of five papers all concerned with " The Constitution of Uranium Alloys." The chair was occupied by Professor G. V. Raynor, vice-president of the Institute and chairman of its Metal Physics Committee, and the papers were presented by a *rapporteur*, Dr. H. M. Finniston.

The first paper was a communication from the National Physical Laboratory and constituted " A Survey of the Uranium-Nickel System," by Mr. J. D. Grogan and Mr. R. J. Pleasance. An appendix on an X-ray examination of these alloys was by Miss Betty E. Williams. The authors stated that the liquidus of the system uranium-nickel took the form of two eutectic troughs; one was composed of U_6Ni and a compound of approximately U_7Ni_6, melting at 740 deg. C., and containing about 10·5 wt.-per cent. (33 atomic-per cent.) nickel, the other of UNi_5 and nickel, melting at 1,110 deg. C., and containing about 71 wt.-per cent. (91 atomic-per cent.) nickel. These were separated by a peak which rose to 1,305 deg. C., the melting point of UNi_5. The solid solubility of nickel in uranium was nearly 0·5 wt.-per cent. (2 atomic-per cent.) at 790 deg. C., and decreased with temperature. The solid solubility of uranium in nickel was about 0·75 wt.-per cent. at 1,000 deg. C., and decreased with temperature.

The second paper, on " Uranium-Lead," was by Dr. B. R. T. Frost and Mr. J. T. Maskrey, of the Metallurgy Division, Atomic Energy Research Establishment, Harwell, Buckinghamshire. The authors said that they had investigated the uranium-lead system over the whole composition range and up to 1,250 deg. C., by micrographic, X-ray, and thermal-analysis methods. The solid solubilities at the uranium-rich and lead-rich ends of the phase diagram were very small, so that lead had little effect on the transformation temperatures of uranium. Two intermetallic compounds were formed, to which the formulae UPb and and UPb_3 had been assigned. They melted congruently at 1,280 deg. and 1,220 deg. C., respectively.

The third paper, on " The System Uranium-Mercury," was also by Dr. B. R. T. Frost, who indicated that the system had been studied over the whole composition range from — 40 deg. to 1,000 deg. C. The solid solubility of uranium in mercury and that of mercury in uranium were both very small. The addition of mercury to uranium had no detectable effect on the transformation temperatures of uranium. Three intermetallic compounds, with the formulae UHg_2, UHg_3 and UHg_4, had been identified.

" Pseudo-Binary Phase Sections between Laves Phases in Ternary Alloys of Uranium " was the title of the fourth paper. It described work carried out at the Fulmer Research Institute, Stoke Poges, Buckinghamshire, and was by Mr. G. B. Brook, Dr. G. I. Williams and Mrs. E. M. Smith. The authors stated that the so-called " Laves phases " were closely-packed compounds of approximate formula AB_2, crystallising in one of three structural types, namely C14 hexagonal, C15 cubic and C36 hexagonal. The phase boundaries at 700 deg. and 900 deg. C. had been determined in the pseudo-binary systems

UMn_2-UNi_2, UFe_2-UNi_2 and UCo_2 and UNi_2. The ranges of composition of the Laves phases showed two characteristic features. At 900 deg. C. the range of the two terminal solid solutions, based respectively on the C15 and C14 structures, became rather more restricted on passing from manganese to iron to cobalt. At 700 deg. C. the phase boundaries were only slightly different, except for an increased solubility of cobalt in UNi_2.

The title of the fifth, and last, paper was "The Constitution of Uranium-Zirconium Alloys"; it was by Dr. D. Summers-Smith and described work carried out in the Associated Electrical Industries Research Laboratory, Aldermaston, Berkshire. The author stated that as a result of work done by metallographic, dilatometric and X-ray methods, using alloys prepared by arc-melting, it had been found that a continuous series of body-centred-cubic solid solutions was formed between γ-uranium and β-zirconium. At 14·5 atomic-per cent. zirconium the γ phase existed up to 693 deg. $\pm$ 3 deg. C., where it underwent a monotectoid reaction; at 69·5 atomic-per cent. zirconium it existed up to 606 deg. $\pm$ 3 deg. C., where it transformed by a eutectoid reaction. A miscibility gap was formed at 693 deg. C. from 14·5 to about 57 atomic-per cent. zirconium. This reached a maximum at 740 deg. $\pm$ 5 deg. C., and 34 atomic-per cent. zirconium. The maximum solubility of zirconium in β-uranium was 2·5 atomic-per cent. at 693 deg. C. The maximum solubility of zirconium in α-uranium at the eutectoid was placed tentatively at about 1 atomic-per cent. The solubility of uranium in α-zirconium was estimated to be 0·75 atomic-per cent. at 606 deg. C.

TWINNING IN CRYSTALS

In the afternoon five more papers were considered in programme "B," the first three were on the theme of "Twinning," and the last two on the "Deformation and Fracture of Zinc." The chair, during the session, was occupied by Professor F. C. Thompson, a past-President of the Institute.

The first paper was by Dr. A. T. Churchman of the research laboratory of Associated Electrical Industries, Limited, Aldermaston, Berkshire, and dealt with "The Formation and Removal of Twins in Titanium during Deformation." The author stated that an electropolished crystal of titanium had been subjected to various degrees of bending, such that the compressive and tensile stresses produced by bending acted along the axis of the specimen. In this manner the stresses could be easily reversed by bending in the opposite sense. It had been found that the deformation twins produced in the crystal by bending could be removed by unbending, i.e., by flattening or straightening the crystal to its original shape, or by annealing to a temperature of 800 deg. C.

The second paper was by Dr. E. Billig, also of the Aldermaston research laboratory, and was entitled "Growth Twins in Crystals of Low Co-ordination Number." The author stated that the steady growth of a monocrystalline ingot of germanium proceeded from the melt essentially as a perfect continuation of the crystal lattice already formed. Growth twins, however, were frequently observed and these seemed to be caused by some unevenness in the growth rate. The small amount of energy required to initiate twinning could be supplied by fluctuations in the temperature and the thermal stresses caused by them.

The third paper, on "Twinning and Un-Twinning in Polycrystalline Magnesium," was by Dr. R. L. Woolley, of the Department of Natural Philosophy, St. Andrews University, Fife. Dr. Woolley stated that he had studied some aspects of the stress-strain curve of polycrystalline 99·98 per cent.-purity magnesium, in shear, for cycles of strain-amplitude less than 10 per cent. After annealing at 300 deg. C., for 8 hours, a specimen had been subjected to the application and removal of a load of 610-kg. per square centimetre, followed by a load of 366-kg. per square centimetre in the opposite direction and then by a load of 732-kg. per square centimetre in the original direction. The resulting stress-strain curves were quite unlike those obtained with cubic metals. Their general character, however, was qualitatively explicable in terms of twinning and un-twinning and the explanation was supported by the results of microscopic observation.

DEFORMATION AND FRACTURE OF ZINC

The two papers on the "Deformation and Fracture of Zinc" were then presented; these constituted the last contributions considered.

The first paper, on "Some Observations on the Deformation of Zinc at High Temperatures," was by Dr. R. W. Cahn, Miss I. J. Bear and Mr. R. L. Bell and described work carried out in the Department of Metallurgy of the University of Birmingham. The authors stated that the orientation relationships between neighbouring units of sub-structure (cells) in grains of hot-deformed polycrystalline zinc had been determined by a new micro-beam X-ray-diffraction technique. The axis about which neighbouring cells were mutually tilted, derived from Laue photographs by a new analytical technique, was always nearly parallel to the basal plane after creep at 250 deg. C., but not always after creep at 350 deg. C. This tilt axis was also parallel to the cell boundary. Tensile experiments with single crystals of zinc had revealed non-basal slip at 350 deg. but not at 250 deg., which was consistent with the observed positions of the tilt axis if the cell boundaries were built up of edge dislocations. Indirect evidence had been obtained that the growth sub-structure present in cast zinc was due mainly to impurity segregation alone and that any orientation differences present must be very small.

The second paper dealt with work carried out in the University of Sheffield on "The Cleavage Fracture of Pure Polycrystalline Zinc in Tension" and was by Dr. G. W. Greenwood and Professor A. G. Quarrell. The authors stated that they had studied some of the cleavage properties of zinc and had investigated the effects of grain size, temperature, strain rate, and plastic deformation on the type of fracture and the true fracture stress. The true fracture stress had been found to be inversely proportional to the square root of the mean grain diameter in tests at $-$ 196 deg. C. This relationship had been found to be valid at higher temperatures if a correction were made for the effect of deformation before fracture. It was concluded that a dislocation theory could be developed to account for the build-up of large internal stresses from which cracks leading to cleavage could result.

The last day of the meeting, Friday, April 1, was devoted to visits to the works of W. H. A. Robertson and Company, Limited, and W. H. Allen, Sons and Company, Limited, Bedford; K. and L. Steelfounders and Engineers, Limited, and Foster Instrument Company, Limited, Letchworth; Wild-Barfield Electric Furnaces, Limited, Watford; and G. A. Harvey and Company, (London), Limited, Charlton, S.E.7; and Vauxhall Motors, Limited, Luton.

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ELECTRICITY SUPPLY IN MARCH

During March, 1955, 7,087 million kWh were sold by the Central Electricity Authority to the Area Boards. This was an increase of 17·4 per cent. over the figure for March, 1954. When corrected for the weather conditions the figure was, however, 11·6 per cent.

The amount of electricity sent out by the Area Boards during March, 1955, was also 7,087 million kWh, of which 146 million kWh were supplied direct by the Central Authority. The increases in the amounts sent out, compared with the corresponding figures in March, 1954, were 14·9 per cent. in the "mainly industrial" and 20·02 per cent. in the "mainly non-industrial" areas.

LAUNCHES AND TRIAL TRIPS

M.S. "VASAHOLM."——Single-screw cargo vessel, with accommodation for a small number of passengers, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, to the order of the Swedish-American Line, Gothenburg, for the joint use of that firm and the Swedish-Eastasiatic Co., Gothenburg, both organisations forming part of the Broström group of companies. Main dimensions: 445 ft. between perpendiculars by 62 ft. by 38 ft. 6 in. to shelter deck; deadweight capacity, 8,575 tons on a draught of 25 ft. 9¼ in.; cargo-carrying capacity, 541,000 cub. ft. (including 37,000 cub. ft. refrigerated space). Eriksbergs-B. and W. seven-cylinder single-acting two-stroke Diesel engine, developing 8,300 b.h.p. Service speed, 17 knots, fully loaded. Trial trip, April 14.

S.S. "DISCOVERER."—Single-screw vessel for carrying bauxite ore, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the Pan-Ore Steamship Co., Inc. (associates of the Alcoa Steamship Co., Inc.), New York. Second of two vessels built for these owners. Main dimensions: 425 ft. between perpendiculars by 60 ft. by 29 ft. 6 in.; deadweight capacity, about 7,950 tons on a draught of 20 ft. 6 in. Double-reduction geared steam turbines developing 3,300 s.h.p. at 112 r.p.m., constructed by David Rowan & Co., Ltd., Glasgow. Steam generated by two Babcock and Wilcox water-tube boilers. Service speed, 12 knots. Trial trip, April 18.

M.S. "SAN PATRICIO."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the Eagle Tanker Co., Ltd., Nassau, Bahamas. Main dimensions: 496 ft. between perpendiculars by 67 ft. 6 in. by 36 ft. 5 in.; deadweight capacity, about 16,050 tons on a summer draught of 29 ft. 1 in.; oil-tank capacity, about 15,400 tons. Eight-cylinder single-acting two-stroke direct-injection oil engine, developing 5,520 b.h.p. at 125 r.p.m. in service, constructed by Sulzer Brothers, Ltd., Winterthur, Switzerland. Speed, 14 knots. Trial trip, April 20.

M.S. "RED GAUNTLET."—Single-screw trawler, built by John Lewis & Sons, Ltd., Aberdeen, for the Iago Steam Trawler, Co., Ltd., Fleetwood, Lancs. Main dimensions: 135 ft. between perpendiculars by 26 ft. 6 in. by 13 ft. 3 in.; fishroom capacity, about 9,300 cub. ft. Five-cylinder Diesel engine, developing 800 b.h.p. at 250 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Launch, April 21.

M.S. "ATHELSTANE."—Single-screw tanker for the bulk carriage of molasses, oil or spirits, built by Hawthorn Leslie (Shipbuilders), Ltd., Hebburn-on-Tyne, County Durham, for the Athel Line Ltd., London, W.1. Second of two sister ships. Main dimensions: 459 ft. overall by 61 ft. by 31 ft. to upper deck; deadweight capacity, about 10,000 tons. Hawthorn-Doxford four-cylinder combined-stroke opposed-piston oil engine, developing 4,450 b.h.p. at 112 r.p.m. in service, constructed by Hawthorn Leslie (Engineers), Ltd., Newcastle-upon-Tyne. Launch, April 21.

"OSPREY" LIGHT VESSEL.—Built by Philip and Son, Ltd., Dartmouth, to the order of the Commissioners for Irish Lights, Dublin, for duty on the South Rock Station off the County Down Coast. Second of three. Main dimensions: 136 ft. 5 in. overall by 25 ft. by 15 ft. The lantern provides a beam 40 ft. above sea level, visible for about ten miles in clear weather. Launch, April 22.

S.S. "TYNEMOUTH."—Single-screw cargo vessel, built and engined by Smith's Dock Co., Ltd., South Bank-on-Tees, for the Burnett Steamship Co., Ltd., Newcastle-upon-Tyne. Main dimensions: 350 ft. between perpendiculars by 51 ft. by 25 ft. 3 in. to main deck; deadweight capacity, about 5,500 tons on a draught of 21 ft. Triple-expansion steam engine, working in conjunction with a Bauer-Wach exhaust turbine, and developing 1,550 i.h.p. at 90 r.p.m. in service. Steam supplied by two multitubular oil-burning boilers. Service speed, 11½ knots. Launch, April 22.

M.S. "OREDIAN."—Single-screw ore-carrying vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for Ore Carriers Ltd., London, E.C.3. Fourth vessel of an order for six. Main dimensions: 407 ft. between perpendiculars by 57 ft. by 33 ft. 4 in.; deadweight capacity, 9,075 tons on a draught of 25 ft. 6 in. Two Gray-Polar five-cylinder Diesel engines coupled to one propelling shaft through Vulcan hydraulic clutches and reduction gearing, supplied by David Brown and Sons (Huddersfield), Ltd., Huddersfield. Service speed, 12 knots. Launch, April 22.

CREEP-RELAXATION TESTING

TESTS AT CONSTANT STRAIN AND DECREASING LOAD

By John H. M. Draper, B.SC. (TECH.), A.M.I.MECH.E.

In the normal engineering creep test, as is well known, the increase in creep strain with time is recorded with a constant load on the specimen. There are some applications in which this does not simulate practical conditions. In a bolted joint, for example, if the bolted members are considered to be rigid, any creep in the bolt will have the effect of reducing the stress in the bolt while the strain remains constant. In the past it has been customary to design for such conditions on the basis of the normal constant-load test data. This method, however, is not entirely satisfactory, and more interest is now being taken in the creep-relaxation test in which the strain on the specimen is held at a constant value, manually or automatically, by decreasing the load as creep proceeds. This article discusses briefly the principles and problems of relaxation testing with particular reference to the writer's own experience.

In tests lasting many thousands of hours, manual adjustment of the load is clearly undesirable. For automatic adjustment of the load to maintain constant strain two distinct methods have been developed. Most investigators in this country have adopted a method in which light contact arms are fixed to the rhombs which carry the mirrors in the Martens mirror type of extensometer used in most high-sensitivity creep-testing equipment. These arms move when the strain on the test specimen is increased, so that the electrical contacts approach one another. When the contacts come together an electronic relay causes a small electric motor to remove load, and consequently strain, from the test specimen. Notable amongst the contact-arm methods is that devised by the National Physical Laboratory, which is fully described in a paper by D. C. Herbert and D. J. Armstrong.[1]

METHOD OF MAINTAINING CONSTANT STRAIN

The present writer has for some years been using an entirely different method of maintaining constant strain on the specimen. Fig. 1 shows the schematic arrangement. The mirrors of the extensometer are fixed in such a way that light from a fixed source A is reflected from one extensometer mirror B to the other extensometer mirror C and thence to a box D containing two photo-cells, which are optically separated. Light is only admitted to one cell at a time, and the width of the light band is adjusted so that it fills the space between the apertures communicating with the cells. The mirror B is concave, and of such a radius of curvature that it gives a sharply defined image of the light slit on the photo-cell box. A small rotation of the mirrors in either direction causes the light-band to shine on one of the cells. The resultant change in resistance of the cell operates through the amplifier E and causes a small electric motor to increase or decrease the load on the specimen so that the light beam moves back into the neutral position between the cells, thus maintaining constant length.

One great advantage of the optical method of control is that if the strain "overshoots" slightly, due perhaps to a high creep rate at the outset of the test, it can quickly be righted without the mirror setting being disturbed. Where contact arms are used there is a possibility that pressure set up between the contacts as a result of overshooting might move the mirror rhombs in their seatings. Another advantage is that if an excessive amount of load is removed, due for example to a momentary change in specimen temperature, the upper cell will readjust the strain to the correct position.

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The method also lends itself conveniently to the initial loading of a test since, with the integrated mirror arrangement, the strain can be seen at a glance from the position of the light band on the curved scale F shown in Fig. 1. The photo-cell arrangement will control the position of the light beam within $\pm 0{\cdot}04$ in. on the scale, equivalent to $\pm 2 \times 10^{-6}$ strain, over long periods of time under normal operating conditions. A limitation of this equipment is that the highest sensitivity can only be obtained with steady input voltage, and reasonably steady atmospheric conditions (the unit is sensitive to damp owing to high resistance in the amplifier circuit).

TEST PROCEDURE

In the early days of creep-relaxation testing, the accepted principle was to load a specimen to a specified *stress* and to maintain constant the strain resulting from this stress. It soon became clear that as creep was often rapid at first, and as time was necessarily taken in loading, the rate of loading considerably affected the conditions under which the test was run. In other words the specified initial stress could be achieved, but the corresponding strain would depend on the loading rate. The next step was to base the test on the elastic strain which would give the required specified stress at the test temperature. This method considerably simplified the test procedure but it was felt that loading to a specified *strain* would give a nearer approach to the practical case in which it is usually the strain that is known, the resultant stress being deduced from it.

Among the cases in which we were first interested were pipe-flange bolts and turbine-cylinder bolts. Here it was decided that the strain should be the same as commonly applied in practice to such bolts, namely, 0·15 per cent. Most laboratories have now adopted the method of loading to a specific strain, and in fact a strain of 0·15 per cent. is commonly adopted. With both contact-arm and optical methods the normal requirements for high-sensitivity creep testing must be satisfied. It is also important to ensure that the extensometers measure correctly the elastic strain during loading. Most authorities agree that this can be troublesome, and discrepancies of up to 5 per cent. sometimes occur, due probably to the difficulty of ensuring axial loading and to the design of the extensometer itself. Care is taken, therefore, in loading at the outset of a relaxation test to ensure that the stress-strain curve is of the expected slope. The curve is plotted as the loading proceeds to check this, and at the same time to check that the curve passes through zero strain at zero stress.

With the optical arrangement the procedure is to carry out a cold loading with the normal telescope and scale arrangement, reading the mirror deflections independently. This is to check that the deflections of the two sides of the extensometer are closely similar and consequently that the specimen is being loaded axially. The integrating mirrors, of course, do not reveal any eccentricity of this type. After removal of the load, it is reapplied, using the integrating mirrors and light beam to ensure that this arrangement gives the same total deflection as before. The load is again removed and the specimen is then heated to test temperature. The light beam is set at a height above the cells representing the strain to be applied, and the load applied incrementally, to give a rate of 0·0002 strain per minute, this rate of straining being maintained until the full value is reached. The band of light will then lie between the two photo-cells. In the early stage of the test it is usually kept in this position by hand adjustment of the load, because the initial creep rate may be too high for the rate of unloading of the servo motor. After a few minutes, however, the automatic control can be brought into operation.

With the contact arm system the strain is usually pre-set, the contacts being separated initially by the required amount. The setting is obtained by normal readings on the mirrors moving with the arms. The load is usually applied according to a specified rate of loading, usually of the order of 1 ton per square inch per minute, or in some cases 5 tons per square inch per minute. Here, too, hand operation is usually necessary for the initial part of the test, until the automatic device can be brought into action.

EFFECT OF LOADING AT DIFFERENT RATES

Since plastic strain is likely to take place during loading, it follows that, for a given initial strain,

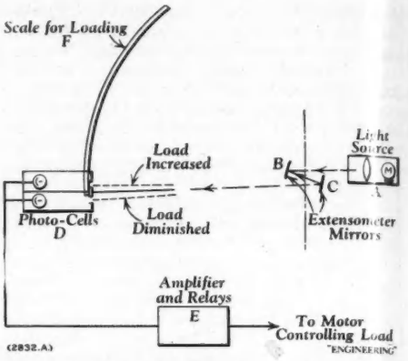

Fig. 1 Schematic arrangement of equipment for creep-relaxation test, showing the extensometer mirrors and photo-cells used for maintaining the applied strain constant.

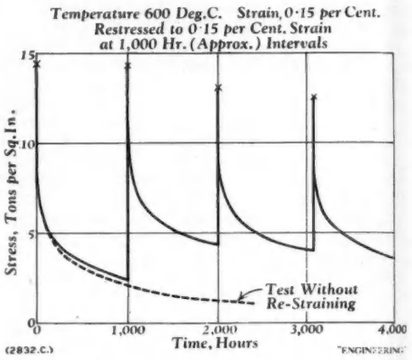

Fig. 2 Relaxation of molybdenum-vanadium steel with and without successive re-straining.

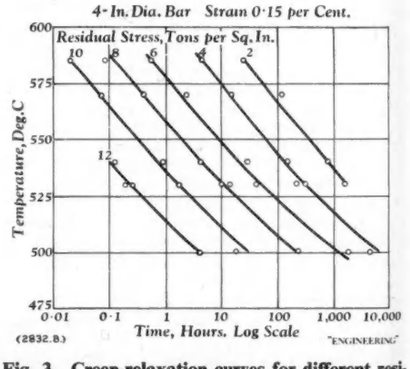

Fig. 3 Creep-relaxation curves for different residual stresses obtained from tests on chromium-molybdenum bolt steel.

differences in loading rate may produce differences in the initial load attained and in the shape of the earlier part of the relaxation curve. In the author's opinion, however, these differences disappear as the test proceeds, so that the latter part of a long-time creep-relaxation curve is substantially unaffected by the loading procedure. However, to make tests consistent with one another in the earlier stages, a standard rate of applying the load should be adopted. The author has adopted a constant rate of straining, which, since the test conditions are specified in terms of strain, appears to be logical. Most other investigators adopt a constant rate of loading.

THE EFFECT OF LOADING AT TEMPERATURE

In most practical cases of creep relaxation the strain is applied before the temperature is raised, or while the temperature is being increased, whereas in the creep-relaxation test as described the strain is applied when the specimen is at temperature. Some interesting tests were carried out some time ago, which suggest that different ways of applying the strain do not greatly affect the subsequent creep performance.

Carbon-steel test specimens, cut from a piece of steam pipe, were tested at 350 deg. C. and 400 deg. C. by the normal creep-relaxation method at a strain of 0·0012. Similar specimens were loaded, by means of nuts at each end of the specimens, in a jig made from a carbon-steel tube (of similar thermal-expansion characteristics) to give a strain of 0·0012. These specimens were then heated, one at 350 deg. C. and one at 400 deg. C. for two separate periods of 200 hours. At the end of each period the specimens were cooled and removed from the jig. The length of each specimen was carefully measured at each stage of the test, and the residual stress in the loaded state after 200 and 400 hours was calculated from the measurements. The applied strain of 0·0012 is equivalent elastically to a stress of 15 tons per square inch, the value of the 0·1 per cent. proof stress at room temperature for this material. There would, therefore, be some plastic strain even during loading at room temperature, and further plastic strain during the heating of the jig-loaded specimens would be inevitable. No significant difference was found, however, between the residual stresses in the jig-load specimens and those in the normal creep-relaxation specimens at the same temperatures and times.

RE-LOADING

In practice, high-temperature flange joints are likely to be re-made a number of times, due to stripping for overhaul, during their life. It is important that the effect of the re-tightening on the relaxation of such bolts should be known. At the same time, it is most likely that re-tightening will affect the total life of a bolted joint in such a way that advantage can be taken of it in the design. In practice, the heating and cooling takes place with the load on, but in a creep-relaxation test, heating or cooling with the specimen strained to the required degree is impractical. The re-tightening is, therefore, copied by leaving the test specimen at temperature and increasing the load until the resultant increase of strain plus the elastic strain remaining in the specimen just prior to re-tightening give the required re-tightened strain (usually 0·0015). Fig. 2 shows the case of a molybdenum-vanadium steel under ordinary relaxation conditions and a comparable test with reloadings.

PRESENTATION OF CREEP-RELAXATION RESULTS

If the strain of 0·15 per cent. is adhered to, a number of tests can be carried out at various temperatures, and continued until the residual stress reaches the value which is envisaged in practice. A plot can then be made of temperature against log-time for specific residual stresses to be reached. An example of this is shown in Fig. 3. Some degree of extrapolation can be made, but until there is more experience in this type of testing, it is felt that long-time extrapolations should only be used with extreme caution.

Acknowledgments.—The author wishes to thank Dr. Willis Jackson, F.R.S., M.I.E.E., Director of Research and Education, and Mr. B. G. Churcher, M.Sc., M.I.E.E., Manager of Research Department, Metropolitan-Vickers Electrical Company, Limited, for permission to publish this article.

REFERENCE

[1] "The Development of a Strain or Displacement-actuated Electronic Trigger for High-Temperature Stress-Relaxation Testing and Other Purposes," *Metallurgia*, vol. 45, May, 1952.

SHORT-TIME CREEP-RELAXATION TESTS

EFFECT OF METHODS OF LOADING

By S. J. Watson, B.SC. (ENG.), WH.SC., A.M.I.MECH.E.*

The relief of residual internal stresses in forgings, castings, welded structures, etc., is commonly effected by heat treatment, and since the stress-relief process is essentially one of creep-relaxation (i.e., relaxation of load under constant strain) useful information on the temperature and soaking time required can be obtained by tensile creep-relaxation tests. While, in practice, residual stresses exist in material in the initially cold condition, it is more convenient in testing to heat the specimen to test temperature before applying the desired initial strain. In this type of testing the temperature is usually high enough to produce almost complete stress relief in a matter of hours, and consequently the rate of straining employed has a pronounced effect on the loading curve obtained, slow straining permitting a considerable amount of plastic flow to occur during the straining period.

The tests described below were made to determine whether the initial straining procedure had any effect on the creep-relaxation curves subsequently obtained. Compared with creep-relaxation tests concerned with the behaviour of materials under service conditions, the temperatures and relaxation rates employed in these tests are very high. It is thought, however, that the results may be of general interest and may apply equally well to long-time tests at lower temperatures.

TEST APPARATUS

In obtaining data for the specification of stress-relieving treatments, the high precision of the normal creep-testing machine is not required, particularly since there is seldom any need to extrapolate such data. These tests were carried out on an apparatus specially designed for this type of work. Its principal features are as follows (see Fig. 1). The straining gear comprises a single lever A of 20 : 1 ratio and a 100-lb. spring balance B suspended from a screwed rod C which passes through the boss of a loading handwheel D. The handwheel can be rotated manually or by a reversible electric motor E with worm drive. The spring balance reading is electrically transmitted to a Kent Multelec recorder and continuously recorded.

The specimen F has a diameter of 0·188 in. and a gauge length of 3 in. A special lever type of extensometer is pin joined to it, and compares its length with that of an unloaded "dummy" specimen of the same material situated immediately alongside, the relative movement being transmitted by quartz push rods G to a 0·0001-in. dial gauge H outside the furnace. The dial gauge reading is transmitted electrically to the Kent Multelec recorder-controller J and can be continuously recorded when desired. The design of the extensometer is such that it is insensitive to bending of the specimen due to non-axial loading, although the loading gear is very carefully lined up to eliminate such bending as far as possible. The use of a dummy specimen eliminates the effects of thermal expansion arising from the small fluctuations in specimen temperature associated with the control differential.

In creep-relaxation testing the strain on the specimen is kept constant by progressively winding off the load as creep proceeds. In this apparatus the strain is represented by the dial gauge reading, the deviation of which from the desired value operates the control contacts in the Kent instrument J and causes the electric motor E to rotate the loading handwheel D and adjust the load in the appropriate direction. Controls for the electric furnace K are arraged so that when

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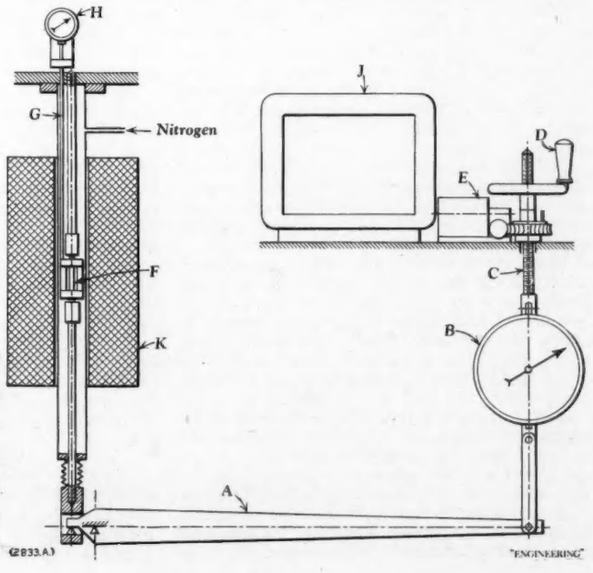

Fig. 1 The apparatus developed for short-time creep relaxation tests. Any alteration in the applied strain is immediately corrected by the mechanisms actuated by the movement of the dial-gauge pointer.

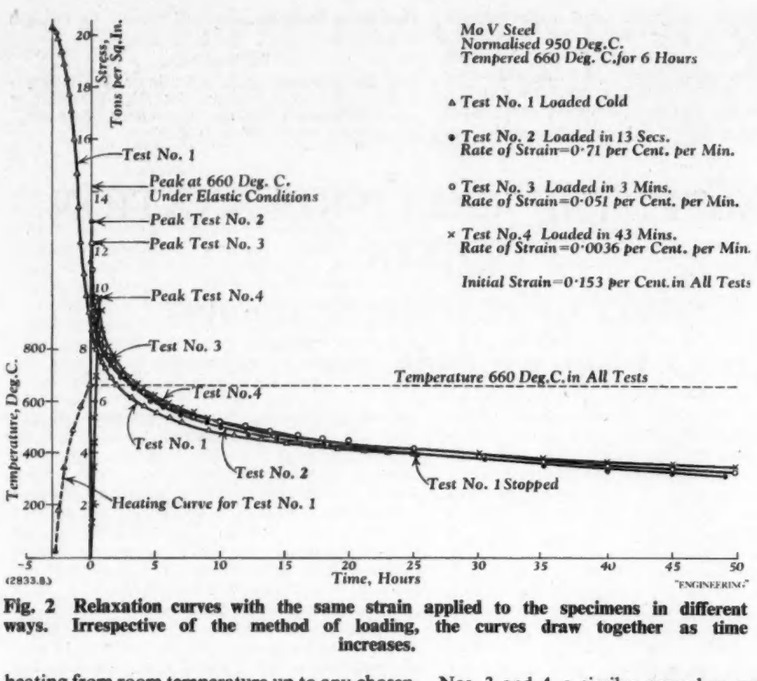
Mo V Steel
Normalised 950 Deg.C.
Tempered 660 Deg. C.for 6 Hours
▵ Test No. 1 Loaded Cold
• Test No. 2 Loaded in 13 Secs. Rate of Strain=0·71 per Cent. per Min.
○ Test No. 3 Loaded in 3 Mins. Rate of Strain=0·051 per Cent. per Min.
× Test No.4 Loaded in 43 Mins. Rate of Strain=0·0036 per Cent. per Min.
Initial Strain=0·153 per Cent.in All Tests
Stress, Tons per Sq.In.
Test No. 1
Peak at 660 Deg. C. Under Elastic Conditions
Peak Test No. 2
Peak Test No. 3
Peak Test No.4
Test No. 3
Test No.4
Test No. 1
Test No. 2
Test No. 1 Stopped
Heating Curve for Test No. 1
Temperature 660 Deg.C.in All Tests
Temperature, Deg.C.
Time, Hours
(2833.B)
"ENGINEERING"

Fig. 2 Relaxation curves with the same strain applied to the specimens in different ways. Irrespective of the method of loading, the curves draw together as time increases.

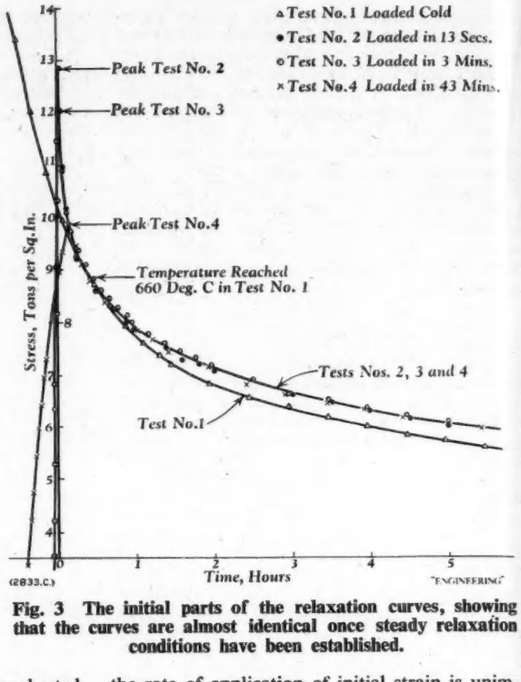
▵ Test No. 1 Loaded Cold
• Test No. 2 Loaded in 13 Secs.
○ Test No. 3 Loaded in 3 Mins.
× Test No.4 Loaded in 43 Mins.
Peak Test No. 2
Peak Test No. 3
Peak Test No.4
Temperature Reached 660 Deg. C in Test No. 1
Tests Nos. 2, 3 and 4
Test No.1
Stress, Tons per Sq.In.
Time, Hours
(2833.C)
"ENGINEERING"

Fig. 3 The initial parts of the relaxation curves, showing that the curves are almost identical once steady relaxation conditions have been established.

heating from room temperature up to any chosen test temperature, the same heating curve is always closely followed. To prevent oxidation of the specimen, a nitrogen atmosphere is provided.

Test Material.—The material used was a molybdenum-vanadium steel having the following analysis:—

C	Si	Mn	S	P
0·215	0·24	0·55	0·037	0·026

Mo	V	Ni	Cr
0·53	0·25	0·28	0·13 per cent.

Test pieces were normalised at 950 deg. C. as rough-machined bars $\frac{7}{16}$ in. in diameter by $6\frac{1}{2}$ in. long, and after final machining they were tempered at 660 deg. C. for six hours in the test apparatus before straining. The Brinell hardness number in the tempered condition was about 290, corresponding to an ultimate tensile strength of 64 tons per square inch.

TEST PROCEDURE

Four creep-relaxation tests were carried out, all at 660 deg. C. and all with a strain of 0·153 per cent. (corresponding to a stress of 20 tons per square inch at 20 deg. C.) but differing in the way in which the strain was applied. In test No. 1, the aim was to apply the specified strain to the cold specimen and maintain this strain constant while heating to the test temperature. Unfortunately, the dummy specimen arrangement described above does not fully compensate for thermal expansion effects during periods of prolonged heating or cooling, and during such periods the dial gauge does not indicate the true strain. To compensate for these effects, a preliminary run was made with a tempered specimen carrying the minimum stress possible in the apparatus (0·25 tons per square inch), and a continuous record of the dial gauge reading was taken during the heating period. In the test proper, another similarly tempered specimen was loaded cold to 20·25 tons per square inch giving the resultant wholly elastic strain of 0·153 per cent. The temperature was then raised to 660 deg. C., in the same rate as in the preliminary run, and during heating the load was continuously adjusted by hand so that the extensometer dial gauge reading varied in the same manner as in the preliminary run.

In test No. 2, with the specimen already at the test temperature at the conclusion of the tempering period, the strain was applied as rapidly as possible by manually increasing the load, the total loading time being 13 seconds. In tests Nos. 3 and 4, a similar procedure was adopted, except that constant strain rates were employed giving loading times of 3 minutes and 43 minutes respectively.

RESULTS OF TESTS

The results of the four tests are shown superimposed in Fig. 2. Zero time has been taken as the time when the specimen reached the test temperature of 660 deg. C. for test No. 1 and as the commencement of loading for tests Nos. 2, 3 and 4. It will be noted that the four relaxation curves are closely similar and that they draw together as time increases. The order of accuracy of the apparatus is such that scatter of ±0·1 ton per square inch might be expected, and after a very few hours the curves lie within this distance of one another. The peak stress reached in tests Nos. 2, 3 and 4 is considerably less than the 20·25 tons per square inch reached in test No. 1 with the same strain. There are two reasons for this. Firstly, the modulus of elasticity at 660 deg. C. is about 70 per cent. of the modulus at 20 deg. C., so that, even if the material behaved elastically during loading, the peak stress would only be about 14·2 tons per square inch, and, secondly, plastic strain occurs during loading and depresses the peak stress still further. Consequently an increase in loading time will reduce the peak stress reached, because there is more time for plastic strain to occur.

Fig. 3 shows the initial parts of the same relaxation curves re-plotted with increased scales, but the curves have been moved laterally so that the peak stresses for tests Nos. 3 and 4 and the stress (8·8 tons per square inch) on reaching 660 deg. C. in test No. 1, all lie on the relaxation curve for test No. 2. This shows that for tests Nos. 2, 3 and 4 the shape of the relaxation curves is almost identical once steady relaxation conditions have been established. In test No. 1, when the specimen reaches test temperature it is under the same conditions and has undergone the same amount of plastic strain as the other specimens at the same stress level (8·8 tons per square inch), but the rate of relaxation is slightly different in the early stages. The difference is small, however, and disappears after 25 hours at temperature.

CONCLUSIONS

The above results indicate that for short-time creep-relaxation tests, as used for stress-relief investigations, substantially the same result is obtained whether initial straining is carried out before or after heating to test temperature, and the rate of application of initial strain is unimportant. This suggests that a stress-relieving heat treatment—where stress is present in the material before heating commences—can be fairly represented by a normal hot-loaded creep-relaxation test.

In long-time creep-relaxation tests representing service conditions, the initial relaxation rate will be very much less than in the present tests. Consequently, the differences in the amount of plastic strain occurring during loading, which are likely to arise from differences in straining procedure, will also be smaller. It therefore seems probable that the results of the long-time tests will be similarly independent of the method of loading except in the initial stages.

While the above tests were confined to a molybdenum-vanadium steel, it is thought that the conclusions may apply also to other ferritic steels. Similar agreement has previously been noted between relaxation curves obtained with hot-loaded and cold-loaded specimens of both 0·44 per cent. carbon steel and 0·5 per cent. molybdenum steel, while consistent families of curves have been obtained with a number of carbon and low alloy steels, despite variations in the straining rates employed.

Acknowledgment.—The author wishes to thank Dr. Willis Jackson, F.R.S., M.I.E.E., Director of Research and Education, and Mr. B. G. Churcher, M.Sc., M.I.E.E., Manager of the Research Department, Metropolitan-Vickers Electrical Company, Limited, for permission to publish this article.

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FIRE-RESISTANT INSULATION BOARD

After successful field tests during the past year in all types of building, a new fire-resistant insulation board is being manufactured by Celotex, Limited, North Circular Road, Stonebridge Park, London, N.W.10. It comprises a sugar-cane fibre core on to which asbestos felt is fused in such a way that none of the original insulating value is lost. The board has been tested by the National Physical Laboratory who have awarded it a British Standards Classification No. 1, which indicates that during the tests there was no spread of surface flame. In a demonstration by the firm, a ½-in. insulation board was subjected to the flame of a fully-charged blow lamp for 45 minutes, with no burning and with only a small amount of heat transmission.

RADIO COMPONENT SHOW

RECENT ADVANCES IN BRITISH RADIO, ELECTRONIC AND TELECOMMUNICATION COMPONENTS

The twelfth annual private exhibition of British components, valves and test gear for the radio, electronic and telecommunication industries was held at Grosvenor House, Park-lane, London, W.1, from Tuesday, April 19, to Thursday, April 21, inclusive. The exhibition is organised by the Radio and Electronic Component Manufacturers' Federation, 22 Surrey-street, Strand, London, W.C.2, and its object is to acquaint those manufacturers and engineers who employ such components with the latest advances in their design and development. Over 140 firms exhibited their products and, as many of the exhibitors showed a dozen or more distinct components, it will be obvious that we can only refer to a small proportion of them. Some of these, however, may be of interest to others than those engaged in the particular industries for which the exhibition was arranged. The exhibition, it should be noted, was not open to the general public, being confined mainly to users and their representatives from this country and overseas. It was formally opened on Tuesday morning by the President of the Federation, Sir Robert Fenwick, Bt., K.B.E., who afterwards presided at an opening luncheon principally for overseas visitors.

VALVES AND CATHODE-RAY TUBES

As the thermionic valve still forms the most versatile electronic component we may refer first to some of the exhibits in this class. In addition to a comprehensive range of valves for broadcasting transmission and reception, radar, television and very-high-frequency links, the English Electric Valve Co., Ltd., Chelmsford, showed some new industrial valves which have been specially developed for use in radio-frequency heating. They are expressly designed for service under the conditions imposed by factory use, being strong and capable of withstanding heavy overloads, and are claimed to be low in first cost and to have a long service life. Both air-cooled and water-cooled types are available in the range and suitable rectifying valves for use with them are manufactured.

Among the new valves shown by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, is the Osram DA42, which is a triode with indirectly-heated cathode designed for use in pairs in public-address amplifiers where output powers of the order of 175 watts are required; an exceptionally good life is claimed for this valve. Other new valves exhibited by the firm included the KT55 power tetrode designed for use as an audio-frequency amplifier; the DH719/EABC80 triple-diode triode and the B719/ECC85 radio-frequency double-triode for use in frequency-modulated/amplitude-modulated radio receivers; the X719 triode-heptode primarily intended for use as a frequency changer; and the W719, a high-slope radio-frequency pentode for use in frequency-modulated receivers. Two new power rectifiers were also shown. Both of these are xenon-filled, directly-heated half-wave rectifiers.

An extensive range of receiving and transmitting valves for radio, television and radar was shown by Mullard Limited, Century House, Shaftesbury avenue, London, W.C.2. These included miniature all-glass Noval-based valves for frequency-modulated/amplitude-modulated radio receivers and a new audio-frequency output pentode known as the EL34. This has a rated anode dissipation of 25 watts and can be used with H.T. voltages up to 800. It is specially suitable for use in audio amplifiers of 20 watts output and over. A recent addition to the Mullard range of all-glass transmitting tetrode valves is known as the QY3-65; its anode dissipation is 65 watts and the maximum operating frequency 250 Mc/s. It is suitable for use as a medium-power driver, frequency multiplier and in the output stages of transmitting sets. A ring-seal tetrode power amplifier, also shown, is suitable for medium-power transmitters in the Band III frequency range.

A notable exhibit on this stand was the new fixed-frequency magnetron which is capable of delivering a peak power of 250 kW and is the largest magnetron made by the firm. Another interesting valve shown was a hydrogen thyratron used to trigger large magnetrons and capable of handling pulses of 200 amperes at powers of several megawatts. Hydrogen thyratrons are claimed to have the special advantages for pulse modulation that they are more efficient than hard valves and are less liable to "jitter" than ignitrons. Valves for radar receivers shown were a local oscillator klystron and a new pentode known as the E180F. The latter employs a new type of control grid, has the very high mutual conductance of 16·5 mA per volt and low interelectrode capacitances. It is recommended for use in radar intermediate-frequency amplifiers and in wide-band amplifiers generally.

Ferranti Limited, Hollinwood, Lancashire, also showed examples of valves for domestic and industrial use and, like most other valve manufacturers, also exhibited cathode-ray tubes for television and other purposes. These are made in all the usual sizes up to 21 in. rectangular. The specialised types of cathode-ray tubes for industrial purposes shown by this firm included flying-spot scanners, oscillograph tubes for recording both voltage and current transients and radar display tubes.

The cathode-ray tubes shown by Mullard included a new 21-in. tube for 90-deg scanning, the special feature of which is that it is 3 in. shorter than 70-deg. tubes with the same screen diagonal. This enables the cabinet dimensions of a television receiver to be kept reasonably small, which is a factor of special importance in table models. A new 3-in. electrostatically-deflected tube shown by Mullard is intended for use in oscilloscopes and monitoring instruments. It has high deflection sensitivities on both axes, a flat screen, and low deflector-plate capacitance.

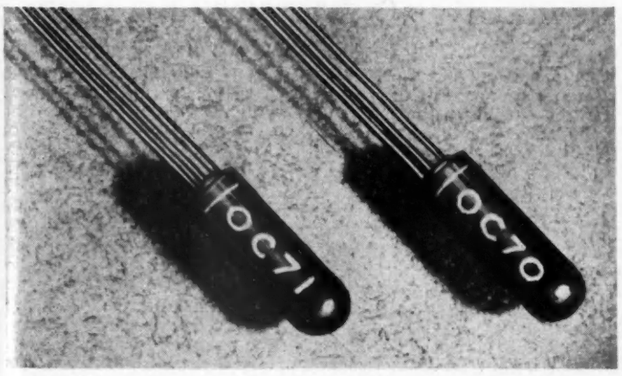


Fig. 1 Pair of Mullard junction transistors shown twice full size.

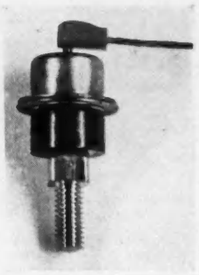


Fig. 2 Medium-power germanium-junction rectifier shown full size. General Electric Co., Ltd.

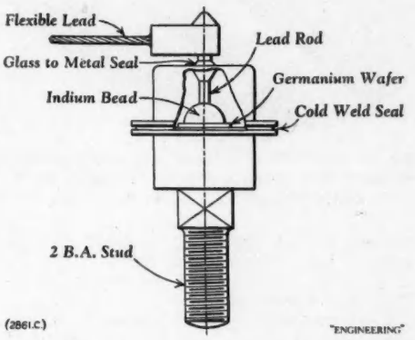


Fig. 3 Section of General Electric germanium-junction rectifier.

The Edison Swan Electric Company, Limited, 155 Charing Cross-road, London, W.C.2, showed a range of new Mazda valves for television and Band II (frequency modulated) radio receivers, and examples of cathode-ray tubes, including 21-in. rectangular types with deflection angles of 70 deg. and 90 deg. Among the industrial and transmitting valves exhibited was a new radiation-cooled triode, known as the ES.1001, having an anode dissipation of 1 kW, and a 12-kW air-cooled triode, both of which are intended for use in radio-frequency heating equipment.

TRANSISTORS AND GERMANIUM RECTIFIERS

Transistors, which can be used in place of thermionic valves for certain purposes, are now being made by several British firms some of whom included examples among their exhibits. Transistors are extensively employed in hearing aids for which they are particularly suitable owing to their low battery-current requirements, compactness, robustness and long life. Mullard Limited are making all-glass fusion-sealed germanium-junction transistors for hearing aids and they are of the opinion that by the end of the current year nearly all such instruments made in this country for the home market and for export will be equipped with transistors. A typical hearing aid of this type was included among the firm's exhibits. Junction transistors are also well suited to applications in intercommunication systems on account of their compactness and their ability to work directly off the low-tension batteries of aircraft. They can also be employed with advantage in special telephones for use in noisy situations. A three-stage audio-frequency amplifier using the junction transistor known as the OC71, was exhibited. This amplifier is constructed on a chassis measuring 3 in. by 2 in., but it is pointed out that these dimensions by no means represent the limit of compactness. The same transistor can be used for such applications as low-power audio oscillators for portable bridges and as a direct-current amplifier to increase the sensitivity of meters. A pair of these transistors is shown at twice full size in Fig. 1.

Pye Industrial Electronics, Limited, also

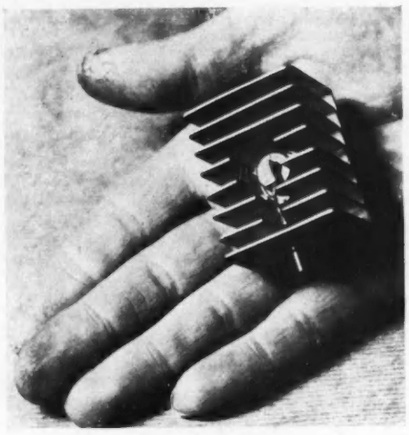


Fig. 4 Four General Electric germanium-junction rectifiers in a bridge circuit with cooling fins as shown will give an output of 1 kW.

showed several types of hermetically-sealed junction transistors intended primarily for use in hearing aids and for low-power audio-frequency amplification.

Three new semi-conductor devices have been introduced by the General Electric Company, Limited, and were included in their exhibit. These were a medium-power germanium p-n junction rectifier, a high-frequency point-contact transistor and a junction transistor. The first mentioned, known as type EW54, is shown full size in Fig. 2 and in section in Fig. 3. It is only 1½ in. in length and ⅝ in. in diameter, but four of them in a full-wave bridge circuit on a 50-cycle supply will provide a maximum output power of 1 kW (50 volts, 20 amperes) with an input at 50 volts r.m.s. Careful attention has been given to the hermetic sealing of the unit to exclude moisture from the sensitive p-n junction. The high power ratings, such as that just mentioned, are obtained when the unit is provided with small cooling fins as shown in Fig. 4, but still higher ratings can be obtained if oil or forced-air cooling is used.

The device has a high rectification efficiency, owing to its very low forward resistance and this, combined with its small dimensions, renders it particularly suitable for use on vehicles and aircraft. With an ambient temperature of 20 deg. C., the rectifier passes a current of 8 amperes at +0·5 volt and of 6 milliamperes at −100 volts. Any increase in ambient temperature, however, results in an increase in both forward and reverse currents at specified voltages. In practice, the absolute maximum operating ambient temperature is 55 deg. C. and the maximum storage temperature 70 deg. C. It is claimed that the rectification efficiency of the device is over 95 per cent. of the limiting theoretical value. The unit is suitable for operation at input frequencies up to a few kilocycles per sec. but the efficiency is reduced at the higher frequencies. Its regulation is also very good. For instance, when a 50-volt r.m.s. input voltage is applied to a full-wave bridge arrangement the output voltage drops from 45 at zero current output to 40 volts with an output current of 20 amperes; this small voltage drop corresponds to an internal forward resistance of about 0·05 ohm. When the EW54 is used in a bi-phase circuit the output voltage must be reduced, although a high output current is permissible. This is due to the fact that the peak inverse voltage in this arrangement is approximately twice that in the full-wave bridge circuit. Consequently, the maximum output voltage in a bi-phase circuit is 25.

The Westinghouse Brake and Signal Company, Limited, 82 York-way, London, N.1, showed examples from a range of germanium crystal rectifiers which offer inherent advantages over thermionic diodes for many radio, electronic and measurement circuits. Their small size and freedom from heater connections are obvious advantages but others are low self-capacitance, wide frequency range, robust construction and unlimited life.

TRANSFORMERS

Transformers of various types play an important part in radio and other electronic apparatus, and examples were to be seen on several stands. A range of "C" cores for single-phase transformers and of "E" cores for three-phase transformers were included in the exhibit of the English Electric Company, Limited, Queens House, Kingsway, London, W.C.2, who also showed examples of hermetically-sealed, open-type and cast-resin transformers incorporating "C" cores. Fig. 5, opposite, shows a typical English Electric transformer. The exhibit of Ferranti Limited, included a range of Pentland resin-cast three-phase transformers and also single-phase transformers, chokes and delay networks employing the resin-cast technique. The Plessey Company Limited, Ilford, Essex, showed a range of extra-high-tension transformers for television purposes, "C"-core transformers, intermediate-frequency transformers and output transformers, the latter including a miniature type for use in "personal" sets in conjunction with sub-miniature output valves and where the primary direct current is limited to a maximum of three milliamperes. Larger sizes for use with 10-in. loud-speakers operating in the 4 to 5 watt range and with high-fidelity equipment having a power output rating of 6 watts, were also shown.

A range of constant-voltage transformers which give a stabilisation within ± 1 per cent., with mains voltage variations up to ± 15 per cent. was exhibited by Advance Components, Limited, Walthamstow, London, E.17. These transformers provide complete protection against transient surges and are self-protecting against short-circuits in the secondary circuit. Partridge Transformers Limited, Tolworth, Surrey, exhibited an extensive range of mains and output transformers, including high-fidelity types, and smoothing chokes. Hermetically-sealed, oil-filled and resin-cast types were shown; advantage has been taken of the properties of grain-orientated strip-wound cores to give high performance in conjunction with compact size and low weight. A new range of miniature transformers and chokes of both sealed and open construction was included in this firm's exhibit. Gresham Transformers Limited, Twickenham-road, Hanworth, Middlesex, also showed a comprehensive range of transformers and chokes for commercial and Service requirements. Types made with "C" cores or standard laminations are included in the range and both types may be open, enclosed, hermetically-sealed, oil-filled or moulded in resin.

QUARTZ CRYSTALS

Quartz crystals for frequency control were shown by Standard Telephones and Cables, Limited, Connaught House, Aldwych, London, W.C.2. Those exhibited covered a frequency range from 4 kc/s to as high as 200 Mc/s. In general, these crystals are mounted in hermetically-sealed cans or in evacuated glass envelopes. Of recent introduction are overtone crystals which are now in production for frequencies up to 55 Mc/s, although the frequency range will shortly be extended. These crystals oscillate in the third, fifth or higher overtone modes, so that the frequency of vibration is increased above the fundamental by the order of the overtone employed. The circuit must, however, be tuned to discriminate between the fundamental frequency and the desired overtone. The use of these crystals will, to a large extent, eliminate the extraneous signals produced by the common technique of frequency multiplication. Salford Electrical Instruments, Limited, also showed overtone crystals for the frequency range from 17,000 to 55,000 kc/s. Cathodeon Crystals, Limited, of the Pye group of companies, Cambridge, showed quartz crystals for frequency control in the range 2,000 to 20,000 kc/s. All are hermetically sealed. Another firm in the same group of companies, Labgear (Cambridge), Limited, showed an oven for crystals having a temperature differential of 1·5 deg. C. and operating from a 6·3-volt supply.

ALLOYS, MAGNETIC MATERIALS, POWDER METALLURGY

Powder metallurgy is now a well-established technique for the production of the special metals and alloys for which many applications are found in the electronic industries. Henry Wiggin and Company, Limited, Birmingham, 16, have recently installed equipment for the manufacture of nickel and its alloys by this process, and their exhibit showed examples of the various forms in which these materials are produced and also illustrated some of the intermediate stages in the process. As is now well known, the constituent powders are weighed and mixed, pressed into compacts, sintered and forged into bars which are then formed into strip, rod or wire by normal hot and cold-working operations. It will be obvious that the powder process enables the composition of alloys to be controlled much more closely than is possible by the normal melting methods which are, of course, impracticable in the case of the more refractory metallic elements, such as tungsten and molybdenum; consequently, important improvements in the properties of alloys can be obtained that are particularly useful in the electronics industry in which alloys having physical properties conforming closely to stringent specifications are frequently required.

Owing to the close control of composition possible in powder metallurgy and the absence of impurities, the firm are able to supply nickel-iron alloys to meet specific requirements in respect of expansion coefficient; ternary alloys of the nickel-cobalt-iron type for making glass-to-metal seals are also available. A very pure grade of nickel, particularly suitable for the components of hydrogen thyratrons, is also supplied. This has a higher temperature coefficient of resistance than ordinary commercial grades of nickel.

An interesting point in connection with magnetic nickel-iron alloys is that, when subjected to a standard heat-treatment at 1,050 deg. C., the permeability is critically dependent upon composition. Owing, therefore, to the closer control possible by the powder process, higher initial permeabilities can be obtained than is possible with alloys produced by normal melting. An important advantage of the former is that the magnetic properties can be fully maintained in strips down to 0·001 in. or less in thickness.

Salford Electrical Instruments, Limited, also had a representative display of ferritic and magnetic powder products, including ferrite cores for transformers, deflection yokes and width-control rods, Gecalloy screw cores, brass-insert cores and bobbins. Magnetic materials in the form of toroidal cores, made in various grades of Permalloy, were included in the exhibit of Standard Telephones and Cables, Limited.

Magnetic materials formed an interesting and important section of the Mullard exhibit. Their well-known Ferroxcube is now produced in a new grade with a substantially rectangular hysteresis loop; the remanence is more than 90 per cent. of the saturation flux density. Small toroids of this material are especially suitable for use in fast computing devices. A new range of Ferroxcube cores has been developed for line-output transformers and scanning coils for 90 deg. television tubes. For line-output transformers the new cores are claimed to give closer coupling between coils and core, resulting in higher inductance for a given number of turns and lower leakage. The cores for scanning coils are produced in the form of 16-slot castellated yokes, shaped to enable them to be fitted closely to the flare of the tube. The use of 16 slots has the advantage of producing a more uniform magnetic field and consequently a reasonably undistorted raster.

A new alloy for permanent magnets, known as Ticonal "L," has been added to the Mullard

range of these materials. It is claimed to have all the advantages of Ticonal with a higher flux density than is obtainable from any other commercially available alloy. This feature renders it particularly suitable for use in loud-speakers. In these, the central-magnet design is more efficient than that employing ring-type magnets, but has hitherto been limited to applications in which a flux density in the gap of about 9,000 gauss was acceptable. With the new alloy, a central-magnet design can be used in high-quality loud-speakers requiring a flux density up to 10 per cent. greater. There are, of course, many applications for Ticonal "L" other than for loud-speaker magnets.

Several alloys for special purposes, most of which are well known, were included in the exhibits of the Telegraph Construction and Maintenance Company, Limited, Greenwich, London, S.E.10. Of these we may mention Mumetal, Radiometal, Rhometal and Permendur. Thermostatic bimetals, beryllium copper and Invar are also made by the firm, and their exhibits included a range of alloys having coefficients of expansion suitable for sealing to various kinds of glass. Resistance alloys, known as Telconstan and Telcuman, can be supplied in the form of wires down to 50 S.W.G. for the manufacture of resistors which are of the highest precision.

Laminations in silicon and nickel-iron alloys, of standard patterns and in sizes suitable for miniature transformers to mains transformers of about 2 kVA capacity, are made by Magnetic and Electrical Alloys Limited, 101–102 Baker-street, London, W.1, who included samples of each in their exhibit. Motor laminations, magnetic screens and toroidal transformer cores were also shown. The latter are made from miniature sizes to diameters of about 14 in. and are supplied in Mumetal, Permalloy, Radiometal, Rhometal and other alloys.

Sintered permanent magnets were shown in many forms by Swift, Levick and Sons, Limited, Leveson-street, Sheffield, 4, who also make cast and forged permanent magnets. Murex, Limited, Rainham, Essex, also showed a wide range of sintered permanent magnets and their products include a range of fabricated parts in pure tungsten, molybdenum, tantalum and zirconium. Many applications for these metals are being found in industry.

METAL RECTIFIERS

For producing unidirectional current from an alternating-current supply metal rectifiers have certain advantages over thermionic valves and several examples of the former were shown at the exhibition. The Westinghouse Brake and Signal Company, Limited, have specialised in these components for many years, the rectifying material employed being generally selenium, although copper oxide is used for certain purposes. Their exhibit included examples of new miniature assemblies in various types of sealed housings. All the miniature rectifiers contain either double or quadruple voltage elements capable of withstanding peak inverse voltages of 42 and 85, respectively. The rectifier units shown for radio and television anode supplies included both the usual spindle types and the recently developed contact-cooled rectifiers for chassis mounting. In the latter type the heat losses are dissipated through the chassis and this feature effects a considerable saving in space with increased efficiency. Rectifiers for industrial power supplies and a special type for tropical use were also shown, together with tubular units of both normal and sealed construction.

In the rectifier units shown by Standard Telephones and Cables, Limited, selenium is used as the rectifying element, and the firm's exhibit included examples from a wide range of miniature components specially designed for the electronics industry. The rectifiers shown were suitable for low-tension, high-tension, extra-high-tension and high-frequency supplies; "Q"-type Unistors which are used as asymmetric resistors in the direct-current circuits of electronic computers were also included in the exhibit of this company.

INSTRUMENTS

A wide range of electronic measuring instruments was shown by Dawe Instruments, Limited, Ealing, London, W.5, including an impedance comparator for production testing, grouping and adjusting inductors, condensers and resistances at a frequency of 10 kc/s. Its range is from 20 μH to 100 μH, 20 $\mu\mu$F to 1 μF and 40 ohms to 100,000 ohms. Among many other exhibits we may mention a portable insulation tester for measuring insulation properties and leakage resistance over the range from 0·1 to 10,000 megohms, a sensitive valve-voltmeter covering the range from a few hundred micro-volts to 30 volts at frequencies between 10 cycles and 100 kc/s, and a "Q" comparator for checking and matching the resistance and magnification factor of coils and condensers in the frequency range from 100 kc/s to 25 Mc/s. We should also mention an interesting instrument, known as a Visigauge, for measuring the thickness of materials from one side only, the thickness being read directly from a calibrated scale on the screen of a cathode-ray tube. The thickness range for steel is from 0·015 in. to 0·3 in.

A range of portable and panel-mounting measuring instruments was shown by Measuring Instruments (Pullin), Limited, Acton, London, W.3. Among the new instruments exhibited by this firm were two multi-range test sets and a probe meter for the detection and measurement of the extra-high voltages employed in television and radar equipment. A range of hermetically-sealed instruments was also shown.

Ferranti, Limited, also showed a range of hermetically-sealed instruments made to comply with the latest Service requirements. Moving-iron type voltmeters for the frequency range from 50 to 2,000 cycles, and a micro-wave test bench for use in the 3-cm. band were also included in this exhibit. The latter was illustrated and described on page 326 of our 178th volume (1954). Electrostatic voltmeters covering ranges from 1 to 18 kV were shown by W. G. Pye and Company, Limited, Cambridge, together with a direct-current microvoltmeter with a full-scale range of only 20 microvolts.

Numerous electrical and electronic servicing instruments were shown by the Automatic Coil Winder and Electrical Equipment Company, Limited, 92-96 Vauxhall Bridge-road, London, S.W.1, in addition to a collection of coil-winding machines and accessories. Two instruments recently introduced by the firm may be mentioned. One of these, known as the Avo wide-band signal generator, has been produced on account of the projected British frequency-modulation and commercial television systems. The former will operate in Band II (80-100 Mc/s) and the latter in Band III (174-216 Mc/s) using amplitude modulation. The provisional specification of the instrument has been determined to meet British requirements and also those of a number of overseas countries. The other new instrument shown was the Avo valve-characteristic meter Mark III. In addition to enabling the anode current to be measured at anode voltages up to 400 with screen voltages up to 300 and with any value of negative grid bias down to — 100 volts, so that complete characteristic curves can be drawn, the instrument also enables inter-electrode insulation and heater continuity to be tested, faulty insulation caused by distortion of the filament or cathode assembly due to the heating of the valve to be measured, and the cathode/heater insulation to be measured with the heater hot. Similar characteristics can be drawn for screen current; the amplification factor and anode resistance can be derived, and the mutual conductance and gas current can be measured directly.

RESISTORS AND POTENTIOMETERS

A form of resistor the resistance of which is dependent upon temperature is now being used for surge suppression, temperature compensation, current-regulation, etc. They are known as thermistors and several examples of them were to be seen among the exhibits. Those made by Mullard, which are known as Varite thermistors, have a negative temperature coefficient of between 3 and 6 per cent. per degree C. at room temperatures, and are available in two types, namely, as rods with wire ends and as small discs. The latter, which are intended for use in temperature-measurement systems and similar applications, have silvered faces to permit good thermal and electrical contact. A number of thermistors sold under the trade name Stantel, were exhibited by Standard Telephones and Cables, Limited, as representative of the complete range available. Examples of bead types and block types of various designs were shown.

A range of precision potentiometers with metal housings, shown on the stand of Salford Electrical Instruments, Limited, may be referred to here. These units employ an improved type of wiper assembly in which the wiper, being horizontal, gives, it is claimed, a more even tracking over the resistance winding. On the type having a twin wiper arm the second arm is now capable of independent movement through an angle of 230 deg., whereas in the earlier standard units the movement was limited to 90 deg. or 180 deg. An improved method of ganging is also used which gives a more compact assembly and also permits the housings to be rotated individually for calibration purposes. A Bakelite former is used in the general-purpose units, but special formers are available for applications involving wide variations in ambient temperature.

Colvern, Limited, Romford, Essex, who specialise in the manufacture of wire-wound potentiometers, showed a wide range of sealed, precision and standard types, the latter being rated at from 1 to 15 watts and including multi-ganged types. Variable and fixed resistors were also included in this exhibit. Labgear (Cambridge), Limited, one of the Pye group of companies, showed a range of wire-wound resistors including vitreous-enamelled, ceramic-bonded and silicone-bonded types. The ceramic-bonded resistors are rated at from 3 to 60 watts and are suitable for operation at temperatures up to 300 deg. C. In addition to extensive ranges of vitreous-enamelled wire-wound resistors and high-stability carbon resistors, Welwyn Electrical Laboratories, Limited, Bedlington, Northumberland, showed a new range of metal-film resistors which are made with resistances up to one megohm and can be used where wire-wound resistors would be too large. They are of cylindrical form and have a stability and

Fig. 5 Example of the English Electric range of "C"-core transformers. The "C"-core construction increases the efficiency by reducing losses, magnetising volt-amperes, and leakage flux.

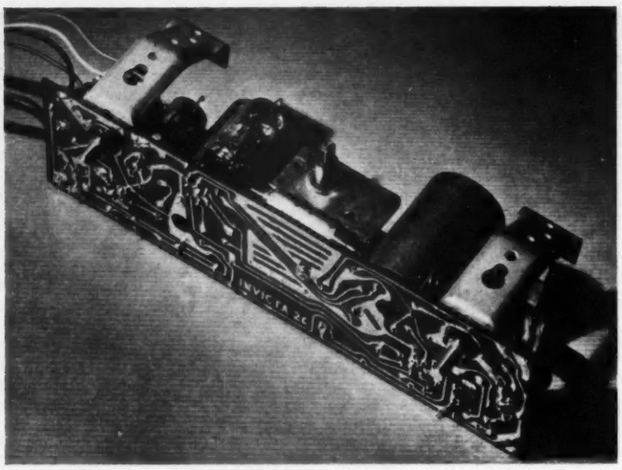


Fig. 6 Radio receiver made up from circuit printed on copper-clad Bakelite without conventional wiring.

high-temperature performance of the same order as wire-wound resistors. A special type of precision wire-wound resistor for tropical use was also shown. They are made to a standard tolerance of ± 0·1 per cent.

A notable exhibit of wire-wound, cracked-carbon and metal-film resistors was also shown by the Erg Industrial Corporation, Limited, 10 Portman-square, London, W.1. These are all wound on non-hygroscopic ceramic formers and can be supplied with vitreous and other coatings. Included in the range were tapped resistors and resistors with Ayrton-Perry low-inductance windings. What are claimed to be the first fully-insulated high-stability resistors to be produced in this country were shown by Erie Resistor Limited, Hendon, London, N.W.9, in addition to solid-carbon and wire-wound resistors.

CAPACITORS

Last year Standard Telephones and Cables, Limited, introduced a complete range of electrolytic capacitors employing tantalum electrodes, and their exhibit this year included examples of recent designs having improved mechanical properties. One of the advantages of tantalum capacitors is that owing to the inert materials used in their construction they do not deteriorate in storage.

Several firms showed variable condensers, and the exhibit of Dawe Instruments, Limited, included a decade condenser box consisting of four capacitors selected by a low-resistance switch so as to provide ten sequential values. One of these boxes gives a maximum capacity of 1·11 μF. in steps of 0·001 μF, or 11·11 μF. in steps of the same value.

Daly (Condensers), Limited, Ealing, London, W.5, specialise in the manufacture of electrolytic capacitors in which the employment of etched foil has resulted in decreased dimensions in all applications. This applies particularly to starting capacitors for alternating-current motors and to reservoir units for photo-flash equipment. It is claimed that the use of etched foil has enabled capacitance values to be made in a single unit for which three or four units had to be employed previously. The exhibit of Erie Resistor Limited, included a range of capacitors, known as Ceramicons, which can be made to closely-defined temperature coefficients from + 100 to − 5,600 parts per million. They are made in an extensive range of shapes and sizes to suit various applications including temperature compensation, by-passing, interference suppression, etc.

Several types of capacitors were included in the exhibit of the Plessey Company Limited. Among them were variable capacitors fitted with integral reduction drives having ratios of 6 : 1, thus rendering other slow-motion drives unnecessary ; miniature plastic-cased electrolytic and tubular paper capacitors were also shown. Tantalum electrolytic capacitors and tubular ceramic capacitors should also be mentioned. Ranges of silvered-mica condensers of the protected and moulded types were shown by the London Electrical Manufacturing Company, Limited, Hammersmith, London, W.6. Those of the moulded type are suitable for operation in the temperature range from −40 deg. to +100 deg. C. under conditions of high humidity. They are available in capacities ranging from 10 pF. to 250,000 pF. A range of silvered-ceramic condensers, of the temperature-compensating tubular type is available up to 500 pF. and both tubular and disc types are made for the range 300 pF. to 0·01 mF. The ceramic condensers, which are made by an associated firm, Fulham Electrical Components, Limited, are finished in a special resin which gives good insulating properties and affords protection from humidity.

PLASTICS

Materials known as plastics are largely employed in the electrical and electronic industries and were in evidence on many stands throughout the exhibition. The exhibit of Bakelite, Limited, 12–18, Grosvenor-gardens, London, S.W.1, was devoted to these materials and among the recent developments was copper-faced Bakelite laminated sheet for the production of the printed circuits which are coming into extensive use. The circuit is printed on to the copper surface with an acid-resisting ink the unprinted part of the copper being then etched away. Holes are punched to accommodate the components and the ink is removed in a trichlorethylene degreaser. On the reverse side of the printed circuit markings indicate the position for each component and after assembly the connections are made by dip soldering in a single operation. Fig. 6 shows a radio receiver made up in this way and it will be obvious that, by eliminating the conventional wiring, this method greatly simplifies the quantity production of radio receivers, amplifiers and similar apparatus.

Among moulding materials exhibited by Bakelite, Limited, may be mentioned alkyds which have excellent anti-tracking characteristics, are stable in both wet and dry heat and are capable of incorporating delicate colour effects. Rubber-modified phenolic compounds are available for general applications where improved strength is required. Among the recent developments shown were glass laminates based upon melamine, silicone and phenolic resins having improved electrical characteristics combined with strength and heat resistance. The Vybak range of polyvinyl-chloride resins and compounds made by the company includes extrusion compounds and moulding materials for the easy production of accessories, and both rigid and elastomeric sheet. The firm's standard ranges of materials such as thermosetting resins for insulating varnishes, valve caps, etc., and polyester resins for the protective coverings of delicate components were also represented.

The plastics division of Thomas de la Rue and Company, Limited, Imperial House, Regent-street, London, W.1, included in their exhibit of laminated plastic materials, plastic extrusions, insulated sleeving and tubing, a new grade of laminate, known as Delaron copper-clad, which is now being used in the production of printed circuits. Several grades of Delaron glass-fibre laminate were also shown. These have been developed to give greater impact strength and heat resistance with improved insulating properties.

Of considerable interest in connection with printed circuits is the embossed-foil technique developed by Erie Resistor Limited, and forming part of their exhibit. In this a simple metal conductor embedded in a high-grade laminate is used and no etching is required.

WIRES AND CABLES

Special cables made by a modified process and claimed to show a substantial improvement in non-microphonic characteristics were exhibited by The Telegraph Construction and Maintenance Company, Limited, who also showed coaxial cables, with suitable joints and terminations, together with screened quad cables for television-relay systems. In the coaxial cables the conductor is a copper rod or tube surrounded by a helical membrane of polythene applied on edge to the conductor and enclosed in an outer tube of aluminium; they are suitable for high-power aerial feeders and other purposes. A recent introduction shown was a range of television downlead cables in which expanded polythene is used as the dielectric. The exhibit of British Insulated Callender's Cables, Limited, 21 Bloomsbury-street, London, W.C.1, comprised radio-frequency cables, miniature multi-way cables, television-camera and relay cables and television downlead cables insulated with cellular polythene. An extensive range of winding wires, including conventional enamelled wires, silicone enamelled wires and wires covered with silk, rayon and other materials was also shown.

Specimens of many types of wires and cables for radio and electronic requirements were

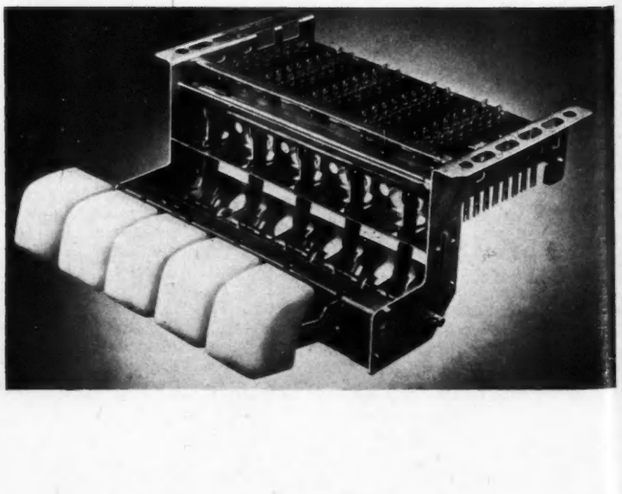


Fig. 7 Wavelength-changing switch with five piano-type keys. A.B. Metal Products, Ltd.

shown by W. T. Henley's Telegraph Works Company, Limited, 51-53 Hatton-garden, London, E.C.1, who manufacture radio-frequency cables insulated with polythene and polyvinyl-chloride compounds. These include coaxial and twin solid types, coaxial types with air spacing, twin balanced television feeder cables both screened and unscreened, and cables for television-transmission lines. A range of wires and cables insulated with polyvinyl-chloride and polythene and sheathed with Nylon was shown by Duratube and Wire, Limited, Feltham, Middlesex, who have recently introduced a type of heat-resisting polyvinyl-chloride known as Duratherm type HP200. It is stated that this material has successfully withstood exposure to a temperature of 120 deg. C. for 200 hours and showed little change after immersion in transformer oil at a temperature of 100 deg. C. for seven days. Coaxial cables for television-aerial downleads were shown by Aerialite, Limited, Stalybridge, Cheshire. In these cables, known as Aeraxial and Super-aeraxial, the polythene insulation is formed with five longitudinal holes to reduce electrical losses. In the air spaced articulated coaxial cables made and exhibited by Transradio, Limited, 138A Cromwell-road, London, S.W.7, air insulation is obtained by spacing the inner conductor by means of hollow high-frequency insulators so that up to 90 per cent. of the dielectric between the two conductors consists of air. With this construction the inner conductor is only in contact with the insulation at intervals and the contact area is very small so that the performance closely approaches that of the ideal air-insulated concentric line.

MISCELLANEOUS

Many of the exhibits cannot be included under the sub-headings used in this account, but some of them should be mentioned. There were, for instance, innumerable examples of switches and relays and one of the former, for wavelength changing, is illustrated in Fig. 7. When one of the five piano-type keys is depressed to bring in a particular station a set of connections is made and those corresponding to a key previously depressed are automatically broken. At the same time, the latter key is restored to its normal position. This switch is made by A.B. Metal Products, Limited, 17 Stratton-street, London, W.1. Among the miscellaneous exhibits may be mentioned a new paper-based magnetic recording tape, known as Puretone, shown by Salford Electrical Instruments, Limited. This tape has a mirror-smooth surface which is claimed to give a high standard of performance. Magnetic recording tape was also shown on the stand of the Minnesota Mining and Manufacturing Company, Limited, Adderley Park, Birmingham, 8. It is sold under the trade mark "Scotch Boy" and will give a response in kilocycles per second at least equal to the speed of the tape in inches per second.

Dawe Instruments, Limited, showed a dynamic balancing machine capable of locating the unbalance of small armatures and similar assemblies on the production line. It can be used by relatively unskilled operators. This firm's exhibit also included a slow-motion stroboscope for a range of frequencies from 10 to 500 cycles per second, and a sound-level indicator covering a range from 30 to 135 decibels. A wide range of relays for both alternating and direct-current supplies, and a special relay for radio-frequency switching were exhibited by Magnetic Devices, Limited, one of the firms in the Pye group of companies, while the parent company, Pye, Limited, showed many new designs which have been recently added to their extensive range of microswitches for aircraft and industrial use. Cathodeon, Limited, also members of the Pye group, showed crash switches, designed for the prevention of fire hazards in aircraft accidents.

The range of Airmax high-efficiency axial-flow fans, made by A. K. Fans, Limited, 20 Upper Park-road, Hampstead, London, N.W.3, now extends from 1 in. to 72 in. in diameter, the two smallest sizes, respectively 1 in. and 1½ in. in diameter, having been added recently. They operate on direct current or on alternating current at a frequency of 400 cycles. Eight different types of rotor are available for each standard diameter and as each gives a different volume/pressure ratio practically any ratio required can be obtained. The smaller sizes are intended for valve cooling and other forms of heat dissipation, but doubtless applications will be found for them in other industries. Fig. 8 shows a group of these fans the smallest among them being the 1½ in. size and the largest being 16 in. in diameter.

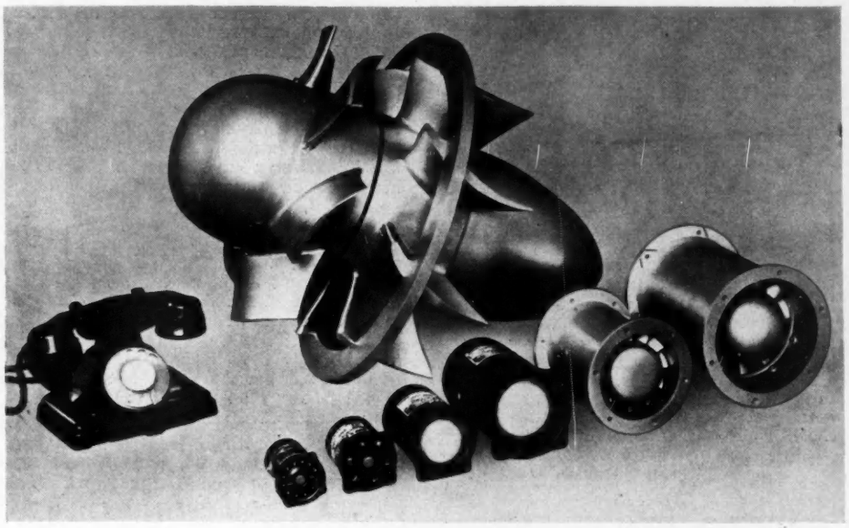


Fig. 8 Group of Airmax high-efficiency axial-flow fans ranging from 1½ in. to 16 in. in diameter. A.K. Fans, Ltd.

Moulded Nylon screws, made and exhibited by Guest Keen and Nettlefolds (Midlands), Limited, Birmingham, may be mentioned as another small component having numerous applications in instruments and apparatus in which steel or other metal screws cannot be employed. The tensile strength of Nylon is of the order of 5 tons per square inch at room temperature but increases as the temperature falls until at −40 deg. C. it is about 7 tons per square inch. Owing to the elasticity of Nylon, care must be taken in driving these screws, otherwise the shanks will extend and the threads strip, but they possess good self-locking properties and will not unscrew from normal vibration. They should not be subjected to loading at temperatures exceeding 135 deg. C. and it should be remembered that Nylon is a hygroscopic material, so that if the screws are exposed to a damp atmosphere they will grow slightly.

GOVERNMENT RESEARCH ESTABLISHMENTS EXHIBITS

The Ministry of Supply arranged a combined exhibit of examples of the work of the three Ministry Research Establishments and as the exhibits cannot conveniently be included under the headings used in the general account of the exhibition we propose to deal with them separately.

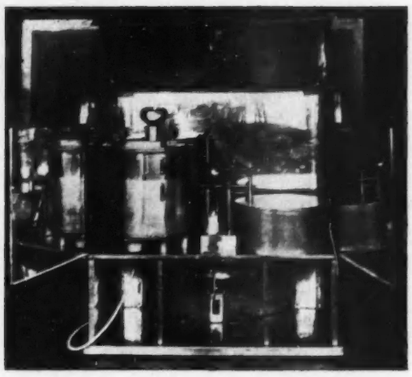
One of the exhibits from the Signals Research and Development Establishment illustrated an attempt to construct a power pack using transistors to replace the conventional vibrator type power unit for man-pack wireless sets. Another was intended to show the progress made in the development of capacitors to operate at higher temperatures, and was illustrated by samples of glass and glaze dielectric capacitors. Work on the measurements of temperature coefficients of capacitors was also shown, including newly-developed equipment for the rapid automatic measurement of these coefficients. This apparatus was demonstrated as also was equipment for determining the temperature coefficient of ferrite toroidal cores.

The Radio Department of the Royal Aircraft Establishment demonstrated the performance of electronic valves developed for military use in which it is necessary for the valves to operate reliably during and after severe shocks and vibrations. They are made by methods which minimise manufacturing errors, and incorporate design features giving the structure great strength and rigidity. Work done with the object of achieving higher operating temperatures with certain components was illustrated by Mycalex-enclosed mica capacitors which give the advantage of controlled temperature coefficient together with very low power factor. Capacitors with polytetrafluorethylene and Terylene dielectric were also shown, as well as selenium rectifiers suitable for higher operating temperatures.

The exhibit from the Radar Research Establishment showed some examples of the extended use of the saturable-reactor technique well known in transductors and magnetic amplifiers. The examples were a 9-kV pulsator and a magnetic pulse generator; a working model of a transductor push-pull oscillator was also shown. Another interesting exhibit was an aluminium plating bath for use in the electroforming of waveguide components and included in the comprehensive range of components shown were oxide-film resistors developed at the Radar Research Establishment for high-temperature use. A notable feature of the stand was a panoramic display illustrating the collaboration between the Government and industry in the production of special components for the Services and Government Departments. The display indicated the source of the requirement, showed the manner in which collaboration is achieved and illustrated the completed component. The work of the Radio Components Standardisation Committee was also featured on the stand.

LARGE ATTENDANCE

Attendance at the Exhibition is reported to have been over 20,000, including visitors from 23 countries overseas, and is regarded by the organisers as the most successful held so far. Mr. C. M. Benham, chairman of the Radio and Electronic Component Manufacturers' Federation, said that the value of British radio components exported during 1954, had amounted to £11 million and was likely to be increased in the current year as a result of the exhibition. It had been particularly noteworthy for the still further improvement in the quality of the components exhibited and for the interest shown by both British and overseas visitors.



In the Peerless Bruin tea dispenser, fresh boiling water is used for each cup of tea made. As one cupful is drawn off, another is brewed. The requisite quantity of milk is simultaneously supplied from a separate reservoir.

SELF-SERVICE TEA DISPENSER

Controlled Brewing

The first self-service automatic tea-brewer and dispenser based on the principles of good tea-making, the Peerless Bruin, has recently been demonstrated by its manufacturers, Peerless and Ericsson Limited, 1 Carlisle-road, London, N.W.9. Designed to increase the speed of the catering service and to standardise costs, at the same time providing the customer with a good cup of hot, fresh tea, the Bruin is based upon the following considerations: (1) An even flow of boiling water must pass through the correct amount of tea leaves at the correct speed. (2) After the tea has been made it must be held away from the spent leaves and at the correct temperature. Each cup must be made individually. (3) The milk must not mix with the tea until both go into the cup.

In the accompanying illustration, the tea magazine and reservoir is seen on the left and the separate milk reservoir on the right. Boiling water from a pressure boiler, operating at from 2 to 8 lb. per square inch pressure, passes up a centre pipe into a spring-loaded needle valve screwed on to a main stem which rests on a float. Under this needle valve is the tea magazine—a basket segmented into eight sections. Each section is filled with a predetermined amount of tea leaves; the amount being determined by the quality of the leaf being used; it can vary from 1⅛ oz. to 1¾ oz. On to this basket and under the needle valve is placed a lid with one section perforated. This whole unit is then placed into a container which holds 4½ pints of tea and is heated to maintain the made tea at 175 deg. F.

When the basket and needle valve are placed into the container it allows boiling water to flow up the main stem through the needle valve and on to the lid. The water passes through the perforated lid, through the leaves and into the container. As the level in the container rises, so the float rises, and cuts the water off after 4½ pints have been made.

The milk container holds ten pints of milk, and is easily removed for cleaning and sterilising. Under the container there is a measuring cup which has its larger counterpart under the tea container. Into these cups is dispensed an exact pre-set amount of tea and milk. Each time a customer's cup is pressed against the lever in front of the machine, the measured liquid drops down the two chutes from the containers into the cup, and the mixed tea and milk reach the cup at about 150 to 155 deg. F.

The two measuring cups are allowed to fill and empty by means of dual-operated valves, one inside the other, which allow liquid either to flow from the measuring cup to the customer's cup or from the container into the measure. Both actions cannot be done together.

On the outside of the lid of the tea magazine there is a ratchet, on which rests a pawl. Each time a customer draws off a cup of tea the ratchet, and in consequence, the lid, is pushed round one notch by the pawl. The result of this is that a part of the lid is located over fresh tea leaves each time a cup is drawn off. As the level in the reservoir drops, so does the float. When the float drops, boiling water flows over the leaves and a fresh cup of tea is made.

The machine will make 225 cups without attention before the basket needs changing. It can serve 600 cups an hour. A warning is given to the operator when 210 cups have been served. The machine can be used continuously, and at maximum draw-off requires the service of an operator only three minutes in every twenty. In industry the machine should have applications on the factory shop floor as well as in works canteens and self-service cafeterias.

* * *

STANDARD BUILDING FRAMES

Designs Based on Plastic Theory

Among the range of standard steel buildings manufactured and marketed by Sanders & Forster, Limited, Hertford Road, Barking, Essex, the storage building illustrated below provides many novel features, both in design and construction. Based on the plastic or collapse theory, and using a tied portal frame as the basis of the design, a building has been developed which has the clean lines of the rigid portal frame, but which uses less steel than the conventional truss and stanchion type of construction.

For planning purposes a 10-ft. module has been adopted, the bay length being 20 ft. This wide spacing of frames, 20 ft., as opposed to the more usual 12 ft. 6 in. or 15 ft. 0 in., has many advantages from the user's point of view, and has been achieved without any substantial increase in the weight of the purlins. These are fixed by a special form of pressed steel cleat, which introduces a very high degree of continuity at the joint, and keeps the deflection of the purlins within allowable limits. In the plane of the roof the purlins are braced by rods which hook into one another. The stanchions for the storage buildings are of very simple construction, being plain lengths of drilled rolled steel joist without caps or bases. The method of fixing is by planting the stanchions in pockets left in the concrete bases, and concreting in after the building is levelled and plumbed. Wall and roof bracing consists of ½-in. diameter rods fitted with turnbuckles which provide a quick and accurate method of "squaring" the building.

The maximum possible use has been made of welding in the shop fabrication of standard components. Site connections, however, are all bolted, and a special detail has been devised at the apex of the roof frame to provide a rigid connection. The number of site bolts has been reduced to a minimum to speed erection.

A large range of sizes of buildings can be constructed from the standard spans and wall heights that are available. Any of the four standard spans, 30 ft. 0 in., 40 ft. 0 in., 50 ft. 0 in. and 60 ft. 0 in. can be erected as single spans or combinations as required in a multi-span building. Four wall heights are available, 11 ft. 0 in., 14 ft. 0 in., 16 ft. 0 in. or 20 ft. 0 in. to eaves. Lean-to's, 15 ft. 0 in. or 20 ft. 0 in. wide, can be provided on the side of a high building, and there are two standard widths of canopy for use with any span; these are particularly suitable for tropical conditions. Gable ends are constructed by hook bolting the gable stanchions on to a standard roof frame. Such a gable end can be easily dismantled and the building extended by adding standard frames.

Normal forms of covering provided for the roof and walls of standard storage buildings are corrugated asbestos cement, aluminium-alloy or galvanised-iron sheets. If an open-sided building is required, or the customer wishes to use local materials for the walls, alternative stanchion sections are available for the purpose, and the side rails can be omitted. All other accessories required to complete the buildings, such as sliding doors, steel windows, Perspex roof lights or patent glazing, gutters and down-pipes, can be supplied in standard sizes to the client's requirements. If additional insulation is called for, internal lining is fixed to the underside of the roof purlins and to the side rails. This provides an air space of four inches between the exterior cladding and the lining.

Standard frames, with a choice of four spans and four wall heights, can be erected as single or multiple-span buildings. Designs based on plastic theories have enabled the weight of the steel to be kept down.

* * *

THRUSTOR-OPERATED PAPER GUILLOTINE

As is well known, the Thrustor, which is manufactured by the British Thomson-Houston Company, Limited, Rugby, is a self-contained electro-hydraulic device which is designed to exert a constant thrust on mechanisms of various types. It can be operated either by a limit switch or by a photo-electric relay.

An example of its recent application is to be found in the guillotine which is installed for cutting sheets at the Snakeley Paper Mill of T. B. Ford, Limited, High Wycombe. On this machine the material is passed under the guillotine head and then between two tables that form an aperture through which the light from a photo-electric relay equipment is projected. When the light beam is interrupted by the material as it is fed between the tables, two Thrustors operate the guillotine so that cutting to the required size takes place. When the cut is completed a third Thrustor tilts the lower table so that the sheet slides clear. When the light beam is restored to the photo-electric cell, the blade of the guillotine returns to the top of its stroke and the table to its original position.

SMALL GAS TURBINE FOR PUMP OR GENERATOR DRIVES

PORTABLE FIRE-FIGHTING PUMP UNIT

Two applications of the 40-75-h.p. Solar Mars gas turbine have recently been demonstrated: first, as a drive unit for a portable fire pump, and second, as an auxiliary power plant for aircraft electrical services. For the latter purpose it was equipped with a 14-kW direct-current generator, but sets are also made (in the United States) with 8-kVA alternating-current generators. The fire-pump application is described here in greater detail.

As announced in our issue of March 25 (pages 359 and 385), a new company, Sugg Solar, Limited, 67 Regency-street, London, S.W.1, a subsidiary of William Sugg and Company, Limited, has been formed to manufacture and distribute the Mars turbine in Europe and the Commonwealth countries, other than Canada, under licence from the Solar Aircraft Company, Limited, San Diego, California. Production in the United Kingdom is expected to commence later this year when Sugg Solar's new works at Crawley, Sussex, are completed and equipped.

The advantages of the small gas turbine for intermittent duties, in which fuel consumption is a secondary consideration, are its low weight and compactness; its ability to operate on Diesel fuel, kerosene or petrol; and its easy starting and accelerating characteristics. The Mars can be started by hand cranking at temperatures down to — 65 deg. F. and at altitudes up to 25,000 ft. Its life between major overhauls is 750 hours, and little servicing is necessary; major overhauls usually involve only the changing of the sheet-metal combustion chamber, some accessories and the two main bearings.

FULL LOAD AFTER 15 SECONDS

The Mars portable fire-fighting pump delivers 415 Imperial gallons a minute at a pressure of 100 lb. per square inch with a 16-ft. suction lift. Weighing only 175 lb., it can easily be carried and hand-cranked for starting by two men. The unit can accept full load 15 seconds after starting. Fire pumps of this type have been ordered by the United States Bureau of Ships for fighting ship fires, and the United States Navy have also placed contracts for Mars turbine-pump units.

Other leading particulars are as follow: overall dimensions without detachable tank and hoses, 27 in. by 24 in. by 25 in.; rated power output, 40/75 h.p.; turbine speed, full load, 40,300 r.p.m. approximately; corresponding pump speed, 4,500 r.p.m.; fuel consumption, full load, 104 lb. per hour; suction line connection (without adaptor), one 4-in.; discharge hose connection, two 2½-in.; compressor inlet air temperature, 27 deg. C.; air flow, 2·3 lb. per second; compressor pressure ratio, 2·44; compressor efficiency, 74·5 per cent.; combustion efficiency, 95 per cent.; turbine efficiency, 78 per cent.; compressor discharge temperature, 158 deg. C.; turbine inlet temperature (average), 616 deg. C.; tailpipe temperature (without cooling), 482 deg. C.

SEPARATE ROTORS

A single-stage centrifugal compressor was chosen for the Mars on account of the limitations on compression ratio imposed by the hand-starting requirement. The need for simplicity and low manufacturing costs dictated the use of a radial-inflow turbine. Separate compressor and turbine rotors are employed, separated by approximately 0·5 in., measured at the hub. They are mounted on the shaft adjacent to the roller bearing in a cantilever arrangement. At rated speed of 40,300 r.p.m., the peripheral speeds of the 6·97-in. compressor rotor and 7·42-in. turbine rotor are 1,220 and 1,300 ft. per second respectively. An elbow-type combustion chamber was selected chiefly to conserve space. For maximum simplicity, the reduction of turbine speed to the pump speed requirement was accomplished by a single spiral-bevel gear and pinion, providing a right-angle drive.

The centrifugal-type compressor rotor is machined from an aluminium-alloy forging, with the rotor-vane leading edges, shaped to form an inducer. The turbine and compressor rotors are mounted back-to-back, with a seal plate between, on a common shaft which extends through the centre of the compressor scroll and air-inlet casing. A nine-vane stainless-steel compressor diffuser is bolted to the scroll. Compressor air is discharged through a bellows-type expansion joint to the combustion-chamber inlet. A butterfly valve in the scroll outlet provides a means of creating a low-velocity area in the combustion chamber during starting to facilitate ignition in extreme conditions.

NO FLAME TUBE

Between the compressor-scroll outlet and the turbine-scroll inlet is a modified elbow-type combustion chamber, formed from thin stainless-steel sheet. It differs from the normal gas-turbine combustion chamber in that there is no flame tube, but only a short, flared, dome-shaped flameholder in the upstream region. A 6·9 gallons per hour, 80-deg. spray-angle Monarch swirl-type nozzle admits fuel to the airstream through the flared skirt of the flame-holder. A 14-mm. aircraft spark plug, set just below the flameholder, initiates combustion.

The radial-inflow turbine rotor is mounted on the shaft with the compressor rotor. Its vanes are shaped to form an exducer in the same manner that the compressor vanes are shaped to form an inducer. The rotor is encircled by the turbine scroll and nozzle, and a short tailpipe is centred behind the rotor hub. No exhaust diffuser is used, but a means is provided for cooling the exhaust gases. Hot gases pass from the combustion chamber into the turbine scroll and are directed tangentially inward by the turbine nozzle vane contour. Thence they whirl farther inward through the rotor and divert through 90 deg. to exhaust axially through the tailpipe. In an aircraft installation an exhaust pipe to atmosphere is installed: ground plants have a short vertical stack which may be used (*a*) to abate noise and (*b*) to divert the exhaust upwards to avoid personnel or neighbouring objects.

Rotary bearings are used exclusively in the power plant, and since the pump impeller is mounted on the speed-reducer output shaft, there are no bearings in the pump. Two main bearings support the turbine shaft in the air inlet housing. A matched pair of angular-contact ball bearings are located on the power-output end of the shaft to take approximately 92 lb. of pinion gear thrust, and a single roller bearing is installed on the rotor end. Radial grooves cut in the mating surface of the outer races provide for pressure lubrication of the ball bearings. Oil at 20 lb. per square inch from the gear-type lubricating pump passes through these grooves on to the inner races. At the high operating speed of the main bearings, air-oil mist is formed in sufficient volume to lubricate the roller bearing also.

The main or output shaft of the speed reducer is supported in a double-row ball thrust bearing and a single-row ball bearing. Accessory drive gear shafts and the gear-type oil pump shafts are each borne in single-row ball bearings. Lubricating oil is directed through a jet nozzle against the out-of-mesh point between the input bevel gear and pinion; the high speed of the pinion here also causes air-oil mist to form and to maintain ample lubrication of the other bearings in the gear housing. Scavenge oil passes by gravity back to the reservoirs.

Fuel for one hour's sustained operation at full load is contained in two portable seven-gallon tanks. During operation, the tank in use is mounted on the tubular frame of the unit. Each tank is connected to the engine by a short flexible pipe and self-sealing coupling. When the turbine is in operation, fuel flows from the manifold through the fuel filter, overspeed shut-off valve, fuel pump and governor to the throttle valve and then to the fuel nozzle. At starting, only the right-hand tank can be used, as the left-hand tank covers the butterfly valve which is essential to starting procedure. After the start, however, either or both tanks can be connected. The self-sealing couplings allow either or both tanks to be replenished during operation without interrupting the fuel flow.

Ignition is required only momentarily during the starting cycle. A magneto and spark plug are used to ignite the fuel-air mixture when the turbine has accelerated to approximately 4,500 r.p.m. The magneto is equipped with a sprocket drive, connected by chain to a sprocket on the handcrank shaft. At 4,500-r.p.m. turbine speed, the magneto is rotating at a speed capable of delivering sufficient ignition current to the spark plug. After ignition, cranking is continued until a speed of 11,000 to 12,000 r.p.m. is reached, at which time the engine becomes self-sustaining and accelerates further under its own power. The handcrank chain drives through a freewheel clutch at the reduction gearbox.

OVERSPEED CONTROL

A simplified control system governs sustained operation once the starting cycle has been completed. Exclusive of the fuel and oil supply systems, only three driven accessories are used. The simple centrifugal governor maintains rated turbine and pump output under varying ambient temperature conditions and during load changes. In addition, there is an independent overspeed control associated with the fuel pump and set to cut off all fuel at about 10 per cent. overspeed.

The fuel pump is a gear-type unit driven off the reduction gear. Its normal rating is 3,250 r.p.m., at which it delivers 46 gallons per hour of fuel to the governor inlet (approximately three times the maximum requirement of the power plant). A booster pump is not needed at starting or otherwise. The governor, mounted on and driven by the fuel pump regulates fuel flow to maintain turbine speed at approximately 40,300 r.p.m., and by-passes excess fuel back to the pump inlet. A minimum-flow valve always assures enough fuel to prevent loss of combustion, even with the governor by-pass wide open at extreme overspeed. The overspeed fuel shut-off valve, driven off the reduction gear, is a spring-loaded, flyweight-actuated shut-off in the fuel line between the tank and the pump. It is opened manually prior to starting and held open by a latch. If the turbine overspeeds, the flyweight releases the latch and the spring closes the valve.

REDUCTION GEAR

Speed reduction between the power unit and the water pump is accomplished by a single-train 9·1-to-1 spiral bevel gear. The pinion is secured to the turbine shaft within the gear housing and meshes with the driven gear mounted on the output shaft. The turbine axis is thus at a right angle to the output shaft. The light-alloy centrifugal pump impeller is mounted on one end of the latter, in the pump housing. The starter sprocket and clutch are mounted on the other end of the output shaft. Spur gears and a pinion on the output shaft drive the fuel pump and governor, oil pump, and overspeed shut-off valve. Gears, shafts and bearings are enclosed in the gear housing, which also forms the lubricating-oil reservoir and sump.

The chain and sprocket arrangement between handcranks and pump shaft, with the gear-and-pinion pump-to-turbine connection, provides an 81-to-1 speed increase in the starting train, and leads to a practicable torque on the cranks during accelerations. When the turbine speed exceeds crank input speed, an over-running freewheel clutch on the pump shaft disengages the starting device. Consequently, one man of reasonable physique can start the unit alone without undue exertion.

BRITISH INDUSTRIES FAIR

ENGINEERING EXHIBITS AT CASTLE BROMWICH

Continued from page 542

PORTABLE AND STATIC HYDRAULIC POWER-PACKS

Finney Presses, Limited, Berkley-street, Birmingham, 1, are exhibiting portable hydraulic power-packs. A small example of this class of equipment has a hydraulic pump driven by a 2-h.p. electric motor, and capable of delivering 0·4 gallon of oil per minute at 5,000 lb. per square inch. A Greer-Mercier accumulator with a capacity of 4 gallons is incorporated.

A new unit in this group is shown in Fig. 13. It consists of a six-cylinder high-pressure pumping unit capable of delivering 5 gallons of oil per minute at 5,000 lb. per square inch, coupled to a double-helical type low-pressure unit which supplies low-pressure boost and force-feed lubrication to the high-pressure unit. The high-pressure unit has provision for adjusting the outlet pressure in the range 1,000 to 5,000 lb. per square inch. The pumps are mounted within a large-capacity oil tank with a drain cock, return oil connection, filler cap, baffle filter, air filter and oil-level sight-glass. A filter capable of removing particles down to 8 microns is fitted in the pump suction line. The complete unit is mounted on a fabricated steel frame with castors for mobility. A control box at one end houses an oil pressure gauge, delivery shut-off valves, manual by-pass valve, gauge-dampening valve, stop-button and oil-temperature gauge. Connecting points, with shut-off valves, are provided to enable the low-pressure delivery to be circulated through an oil-cooler if necessary. The unit is designed for constant-delivery applications only. Two 2-gallon Greer-Mercier accumulators can be fitted to smooth out pulsations if desired.

An example of the use of a power-pack in a static installation is provided by a unit which supplies power for a 50-ton downstroking Finney hydraulic plastics moulding press. It consists of a tandem pump directly driven by a 1½-h.p. electric motor and delivering oil at 0·4 gallon per minute and 2,240 lb. per square inch. It is coupled to a 4-gallon capacity Greer-Mercier accumulator, the combined capacity being sufficient for one press-cycle per minute.

HYDRAULIC EQUIPMENT

Specimens of their Greer-Mercier hydro-pneumatic accumulators and shock-alleviators are also exhibited by Finney Presses. Shown in various applications, a typical example is the 200-ton Finney downstroke hydraulic press (Fig. 15), which is powered by a hydraulic pump unit supplying oil to two hydro-pneumatic accumulators. The hydraulic pump is a Finney "S" type single-stage unit, with a capacity of 0·2 gallon per minute at 5,000 lb. per square inch. It is driven by a 1½-h.p. electric motor and mounted below the press base. Oil is delivered to two eight-gallon Greer-Mercier accumulators, the combined capacity of which is equal to a 5-minute press-operating cycle. The press has a platen 24-in. square, with T-slots, and 20 in. clearance between platens. Speed is adjustable by a graduated needle control-valve from zero to ½ in. per second, and the pressure can be adjusted from 200 down to 100 tons.

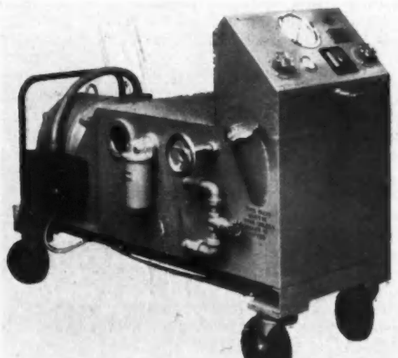


Fig. 13 Portable hydraulic plant supplying 5 gal. of oil per min. at 5,000 lb. per sq. in. Finney Presses Ltd.

SMALL TOOLS AND MEASURING EQUIPMENT

Among the exhibits of Alfred Herbert, Limited, Coventry, is a large selection of the engineers' small tools and measuring equipment which they manufacture, or for which they act as selling agents. The small-tools group includes lathe tools and machine accessories, and examples of Sigma multi-dimension inspection machines and comparators, Hilger enlargers and projectors, and Watts measuring equipment, levels and clinometers, together with a Taylor-Hobson Talysurf surface-finish measuring instrument.

TWO-SPEED MACHINE VICE

A new product for which Alfred Herbert, Limited, are the United Kingdom selling agents is the "Hylo" two-speed vice. The vice, which is illustrated in Fig. 14, has a fixed jaw and an adjustable jaw which runs on inverted V-guides at 60 deg. The moving jaw is controlled by a differential mechanism which enables it to approach the work at high speed and then slow down to grip it with increased leverage. The mechanism consists of a common shaft with two threaded portions of 0·5 and 0·4-in. pitch respectively. The 0·5-in. pitch primary thread screws into a nut fixed to the base casting and the secondary thread (0·4 in. pitch) screws into a nut which abuts the plain portion of the shaft between the two threads. The nut is held in this position by a preloaded spring, one end of which is attached to the nut and the other to the shaft. When the shaft is turned in a clockwise direction it screws into the primary nut and carries the secondary nut with it. This latter nut is free to revolve in a bracket fixed to the rear of the moving jaw. Lateral movement of the secondary nut is prevented by a flange at the back which is in contact with the bracket and a Circlip at the front. The moving jaw travels at 0·5 in. per revolution of the shaft until it makes contact with the work; pressure then builds up to overcome the energy of the spring and the secondary nut ceases to revolve. The shaft then screws through both nuts and as a result of the difference between the pitches the moving jaw advances 0·1 in. per revolution of the handle. The process is reversed by turning the handle anti-clockwise, and the work is released. The vice, made with jaws 4½ in., 6 in. and 8 in. wide, has a base which is prepared to accommodate tenons, and provision is also made for mounting on a swivel base. A forged-steel handle is supplied with each vice.

WORKS TRUCKS AND TRACTORS

The range of materials-handling equipment shown by the Yale and Towne Manufacturing Company, Wednesfield, Wolverhampton, includes a new hand-operated hydraulic lift-truck and an electric-battery tractor. The lift-truck, which is available in both platform and pallet types, has four ball-bearing wheels, the front pair being pivoted and provided with a towing handle, the arc of movement of which is 200 deg. The steering wheels are rocker-mounted, to ensure four-point contact with the ground at all times. The truck is made in two capacities: 4,000 lb. and 6,000 lb. Elevation of the platform is by a hydraulic pump and jack operated by the towing handle. A pre-set relief valve in the hydraulic system prevents overloading of the truck. Lowering of the platform is controlled by a pedal, mounted at the front, and duplicated for operation by either foot. The load is lowered against the pressure of the hydraulic system, and the lowering speed is varied by the pressure on the pedal.

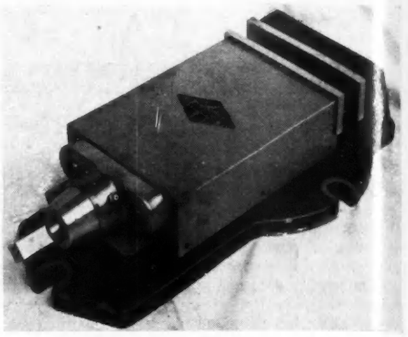


Fig. 14 Machine-tool vice with fast approach mechanism. Alfred Herbert Ltd.

The electrically-driven tractor (Fig. 16) is powered by two six-cell, 11 or 13-plate batteries. It has three travelling speeds, and uses the batteries in parallel for first and second speeds, and in series for third. The change from parallel to series operation is automatic, by means of contactor gear mounted behind the battery container. The tractor can be controlled when in first or second speed by a pedestrian operator; alternatively, the operator can be seated on the battery container, the control handle being pivoted to swing to either position. Control in these two speeds is by finger-touch cams on the steering handle. The third speed, which is in excess of 5 m.p.h., is too fast for pedestrian control, and the tractor has been arranged so that this speed can only be engaged when the operator is seated. A spring-loaded button set in the footplate engages the third speed after a time-delay; when the operator releases the button the control reverts to second speed.

The tractor has a draw-bar pull of over 700 lb., and the speeds of travel can be arranged to suit the user.

INDUSTRIAL GEARS

A pair of hypoid gears and a range of fractional horse-power worm-reduction gearboxes, representing roughly the largest and smallest products respectively of the Moss Gear Company, Limited, Tyburn, Birmingham, 24, are the outstanding exhibits on the company's stand. The hypoid gears, which are used in the construction of papermaking machinery, are claimed to be among the largest yet made in this country. They have a D.P. of 2·2 and a face-width of 4·5 in. The pinion, which is 10 in. in diameter, is offset 4½ in. from the centre-line of the wheel, which is 27 in. in diameter. There are 17 teeth on the pinion and 60 on the wheel.

The fractional horse-power worm-reduction gearbox, is designed for universal mounting, and is made in three sizes, 1¼ in., 1⅝ in. and 2¼ in. centres. The worm is of nickel-

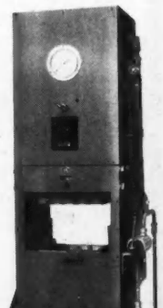


Fig. 15 Down-stroke hydraulic press; 200 tons capacity. Finney Presses Ltd.

Fig. 16 Electrically driven 3-speed tractor; with drawbar pull of 700 lb. Yale and Towne Manufacturing Co.

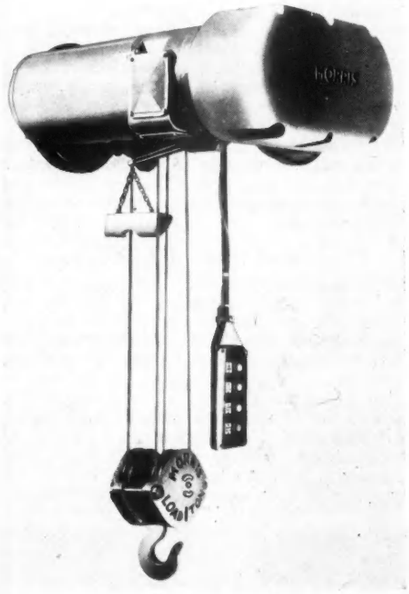


Fig. 17 Electric hoist block with fast and slow speeds. Herbert Morris Ltd.

alloy steel, and works with a phosphor-bronze worm-wheel with hobbed teeth. The gearcase is of cast iron, and is faced, jig-drilled and tapped in several positions to enable the feet to be attached in various ways according to the required positions of the drive and output shafts. By the use of one or other of two different types of feet—standard, which are normally supplied, or vertical, which are available when required—it is possible to mount the gearbox in any one of thirty-two different positions. The gears are lubricated by the "dip" method, the oil thrown up by the gears penetrating to all the bearings, and being conducted back to the sump by drain channels. Oil seals are provided at the shaft extension, and a level-indicating plug is fitted in the box. The shafts are mounted in ball bearings of the combined thrust and journal type, and they are designed to carry a lightly-loaded external spur gear or chain sprocket. Standard ratios range from 5·2 to 1 minimum to 60 to 1 maximum, 10·5, 20, 40 and 60 to 1 usually being in stock. Special ratios within the stated range can be made. Typical horse power ratings on the input shaft are: from 0·180 at 750 r.p.m. to 0·302 at 1,800 r.p.m. on the 1⅛ in. size, and from 0·675 at 750 r.p.m. to 1·17 at 1,800 r.p.m. on the 2⅛ in. size. The smallest box in the range weighs 7 lb. and the largest 22 lb.

ELECTRIC HOISTS

The range of mechanical-handling equipment on the stand of Herbert Morris Limited, Loughborough, includes a new electric chain hoist in capacities up to 1 ton, and a two-speed hoist capable of lifting ½, 1, 2, 3 or 5 tons. The chain hoist is available for 220/250-volt alternating current and has an enclosed mechanism, with tempered-steel gears running in a sealed oil-box. Load sustaining is automatic, and over-hoisting and over-lowering are prevented by the rising hook or the looped chain rotating the switch lever, thus cutting off the current to the motor. Control is by a single handle suspended from the switch lever.

The two-speed hoist block (Fig. 17) lifts on steel wire ropes, and is specially designed for use in foundries, machine shops or other situations where very slow lifting and lowering speeds are required. The power unit consists of two rotors mounted on the same shaft and working within a common stator which embodies the main and auxiliary windings. The hoist is controlled by a pendant push-button box with four push-buttons, two for the normal speed and two for the slow speed. The push-button box is connected to two enclosed contactor units, and the contactors and push-buttons are fully interlocked. Once a speed and direction of travel have been selected and the appropriate button pressed and held, accidental or deliberate operation of any of the remaining three buttons is completely ineffective. The speeds of hoisting and lowering under the normal or "fast" controls are: 30 ft. per minute for the ½, 1 and 2-ton sizes, 25 ft. for the 3-ton size, and 20 ft. for the 5-ton. Slow hoisting and lowering are at 5 ft. per minute in all the five sizes of hoist. Over-hoisting is prevented by a cut-off switch operated by the bottom block. The hoist is supplied for suspension from a single point, for travelling along a steel joist by pushing the load, or for racking along by hand chain. It can also be fitted with power travel for both straight tracks and tracks with sharp curves.

RACKFEED DRILL

Among many other small tools being shown on the stand of Desoutter Brothers, Limited, The Hyde, Hendon, London, N.W.9, is the rackfeed drill that they have introduced recently. This is pneumatically driven and is intended to simplify the drilling and reaming of holes larger than ½ in. in diameter. Being a portable hand tool, it avoids the necessity for taking large work to a fixed drilling machine, and the rack feed relieves the operator from excessive fatigue. The drill is illustrated in Fig. 18.

In operation, a drilling jig with special guide studs is clamped to the work. The nose of the drill is then pushed into the jig bush and the body given a quarter turn to lock the bayonet nose-fitting under the stud collars. The handle is rotated, advancing the tool by a reduction gear until the drill tip approaches the work when the driving air is switched on automatically. After the hole has been drilled or reamed, the tool is withdrawn by turning the handle in the opposite direction, the air being switched off as the drill leaves the work. All the drilling reaction forces are absorbed by the bayonet fixing, which also gives exact location for the hole. An adjustable stop on the rack controls the depth of penetration.

PROPELLER FAN

The fan exhibits on the stand of Keith Blackman, Limited, Mill Mead-road, London, N.17, are all available from stock for immediate delivery. The type APA three-bladed propeller

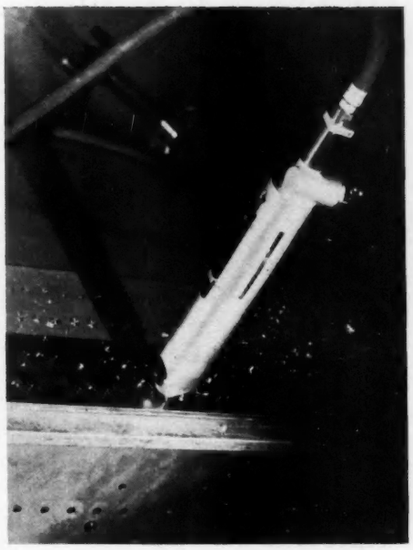


Fig. 18 Rack fed pneumatic drill for holes of ½ in. diameter or over. Desoutter Brothers Ltd.

fan they are showing, illustrated in Fig. 19, is an improved version of the one shown for the first time last year. The anticlastic (double curvature) blade formation, it is claimed, gives a large volumetric capacity and high efficiency with exceptional quietness in operation. The impellers are dynamically balanced to ensure vibrationless running. The electric motor housing is mounted on patented "antisonic" mountings incorporated in the tubular-steel mounting arms, the motor itself being carried in ball thrust bearings.

Each fan blade is made in one piece from sheet steel. The impeller hubs are of cast iron, and the blades are attached to the hub by round-headed bolts and special lock nuts. This type of fan is recommended for use where very large volumes of air have to be moved efficiently and quietly under free air conditions or a slight resistance up to about 0·6 in. static w.g. It is available in six diameters, from 18 in. to 48 in., and in capacities from 1,525 cub. ft. to 31,000 cub. ft. per minute.

(*To be continued*)

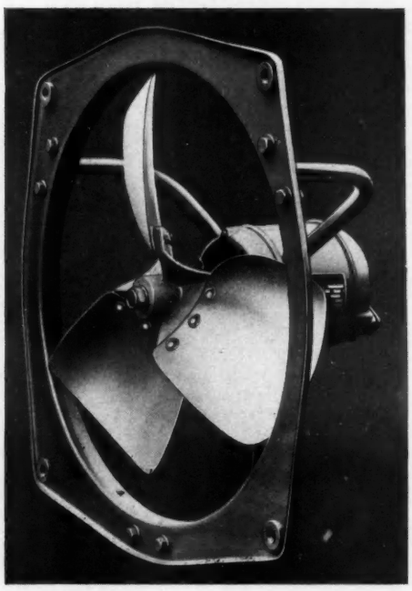


Fig. 19 Propeller fan with large capacity and silent operation. Keith Blackman Ltd.

ADDITIONAL GAS SUPPLY FOR THE POTTERIES

ETRURIA WORKS AT STOKE-ON-TRENT

The new 8 million cubic feet per day carbonisation plant at Etruria Gas Works, Stoke-on-Trent, which was inaugurated on April 20 by Col. Sir Harold Smith, K.B.E., D.L., M.I.C.E., M.Inst.Gas.E., chairman of the Gas Council, was built to meet increasing industrial and domestic loads in an area where gas has done much towards eliminating smoke.

Gas manufacture in the Potteries area of North Staffordshire commenced in 1825, when works were erected at Shelton. Subsequently, other works were started in different parts of the area, and when the " Five Towns " (there are really six—Stoke, Burslem, Fenton, Longton, Hanley and Tunstall), were incorporated into one County Borough in 1908, Hanley and Tunstall were supplied with gas from a works at Etruria, and Burslem, Stoke, Fenton and Longton each had their own independent works. These latter works were taken over by the newly-formed County Borough of Stoke-on-Trent and the Etruria Works were acquired in 1922. Eventually, manufacture of gas was concentrated at Etruria, and the other works were closed down. In May, 1949, when the works were vested in the West Midlands Gas Board, there were 71,488 consumers, a figure which has since risen to 78,842.

Numerous additions to manufacturing capacity at Etruria were supplemented by bulk supplies from local coke-oven plants. In 1935, arrangements were made to take unpurified coke-oven gas from the nearby works of the Shelton Iron, Steel and Coal Company, Limited. At present about 5 to 6 million cub. ft. of gas per day are received from this source. Purified gas has been obtained from the Birchenwood Gas and Coke Company in the northern part of the distribution area since 1938, and this gas is fed directly into the distribution mains at approximately 2 million cub. ft. per day. Plans for further extensions were already in hand when the Gas Board took over the undertaking in 1949. The use of gas in gas-fired tunnel kilns for pottery manufacture had started in 1932, when the first kiln of this type was installed in the area, and the expansion in gas-firing has been so great that there are now 300 tunnel kilns in operation, the consumption, in 1954, being 5,179,149,000 cub. ft. In addition, large quantities of gas are used for numerous other industrial purposes, and the domestic load has increased greatly as a result of the local housing programme.

In 1947, therefore, Mr. J. E. Stanier, the present divisional general manager, North Staffordshire Division, West Midlands Gas Board, who was then chief engineer and general manager for the City undertaking, prepared plans for new plant of 8 million cub. ft. per day capacity. The plans were approved in 1948, and have since been put into operation by the Gas Board.

SELF-CONTAINED WORKS ON A NEW SITE

No space was available at Etruria for the erection of new plant, but a site immediately adjacent was obtained, and the new works, in the form of a self-contained unit, were built there. The site, of approximately 4·8 acres, had been used as a railway-wagon repair works, and it was necessary to clear away the old buildings and level the land before construction could be started. The new works, though self-contained in character, adjoin the old, and are connected into the existing sidings. The main Stoke-Crewe line of British Railways forms the boundary on the south-west, and the old works are on the north-west. The site is completely surrounded by a railway siding. The plant has been arranged in four parallel lines at right angles to the main railway tracks. The four lines comprise:

(*a*) The retort house and coke-screening plant;
(*b*) De-tarrers, condensers, exhausters, reciprocating gas compressors, generator and switchgear house and ammonia washers;
(*c*) Oxide store shed and tower purifiers;
(*d*) Station meters and calorimeter room, benzole washers, tar and liquor wells, benzole recovery plant, water-circulating pump house, rail weighbridge and water-cooling tower.

CARBONISING PLANT

The retort house, designed for making 8 million cub. ft. of gas per day, is of steel-framed construction encased in brickwork. It contains 96 Glover-West 50-in. continuous vertical retorts, grouped in four separate benches each of three settings; each setting contains eight retorts in heating units of four. This principle of setting makes it possible for each bench of 2 million cub. ft. daily capacity to be laid-off independently of the others for major repairs or re-setting. The settings are designed for balanced heating. Fuel gas is supplied by pressurised integral step-grate producers, one to each setting and coupled together by common external producer-gas flues, one to each bench, with branches to the individual settings and the necessary control dampers. Primary air is supplied to each bench by a motor-driven fan (which is duplicated), through a common duct with branches to each grate. Steam is injected into each branch. The volume of air and the temperature of the air/steam mixture are measured and indicated at each producer.

The retorts and combustion chambers in each bench have been built in different refractory materials, and it is intended to keep them under observation and report to the refractories industry in due course.

WASTE-HEAT RECOVERY

Waste-heat from the retort settings is recovered in three Spencer-Bonecourt boilers, each of which will deal with the gases from two of the four benches, but will also work efficiently on reduced loading when all three boilers are in operation. Alternatively, any boiler can be shut down for cleaning when required. The boilers are of the horizontal, induced-draught, fire-tube type. They work at 180 lb. per square inch pressure, with superheat 150 deg. F. above saturation temperature, yielding 4 lb. of steam per lb. of coke consumed in the producers.

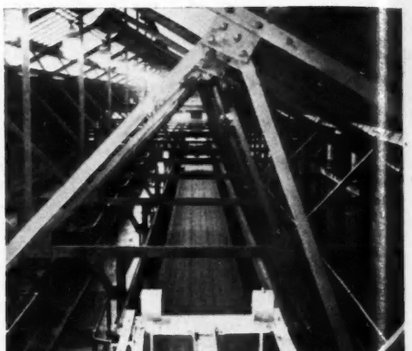


Fig. 1 Coal is elevated at both ends of the retort house and then carried by belt conveyors to bunkers over the retorts.

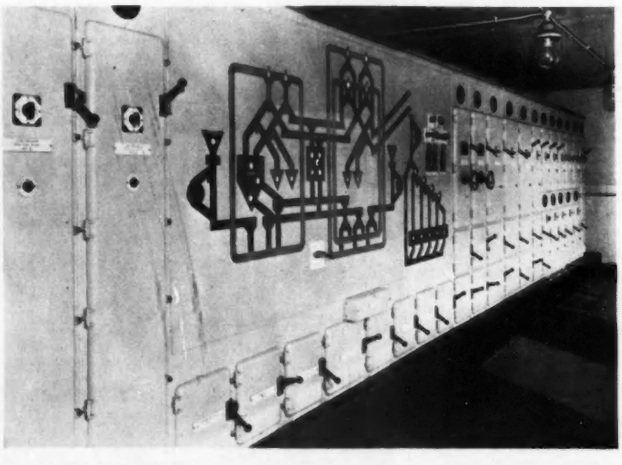


Fig. 2 The electrical equipment for the coal and coke-handling plant is controlled from a panel with an illuminated diagram showing which units are in operation.

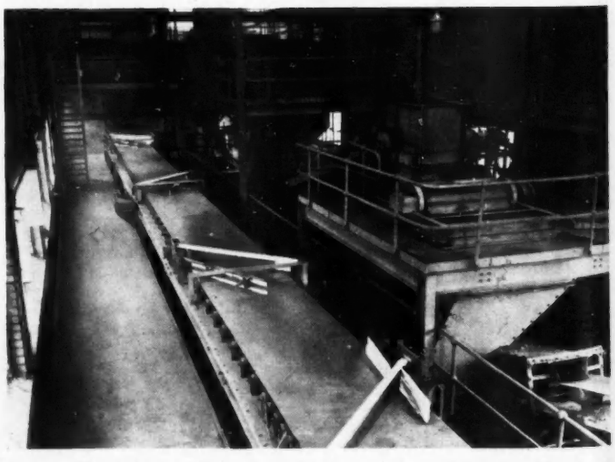


Fig. 3 Coke is graded on two lines of screens above the storage bunkers. A line of West's selective band conveyor screens is seen on the left, and a line of Pegson-Telsmith screens on the right.

Induced-draught on each boiler is by a Sirocco fan with a 20 per cent. volumetric overload capacity, driven by a Greenwood and Batley geared back-pressure steam turbine. The turbines exhaust at 30 lb. per square inch, and the steam can be used either for the retorts or for feed-water heating. At present the steam is used in three Weir feed-water heaters, one for each boiler, which raise the temperature of the feed-water to 200 deg. F. when supplied with steam at a pressure of from 2 lb. to 30 lb. per square inch. Condensate from the feed-water heaters is returned to the feed-water softener.

COAL SUPPLY

Coal is received by rail or road at both ends of the retort house. Rail-borne coal is discharged from the wagons by duplicate Waller hydraulic tipplers, which are so arranged that wagons can be discharged from either end. A duplicate set of Dawson and Downie vertical three-throw pumps, driven through gearing from 14-h.p. electric motors, supplies hydraulic power, the delivery rate and pressure being 2,000 gallons per minute and 380 lb. per square inch, respectively. The tippers can deal with 25-ton wagons.

Coal is discharged by the tipplers into 25-ton hoppers, which are extended at the outsides to receive coal from road vehicles. An adjustable mechanical feeder below each hopper delivers coal to a West's single-roll coal breaker capable of reducing 80 tons of coal per hour to a size not exceeding 2 in. cube. From the breakers, or by-passing them from the feeders, coal passes by an inclined steel-tray conveyor delivering to West's lip-bucket conveyors at the ends of the retort house. These conveyors elevate the coal to the bunkers over the retorts. They are supported by steel structures built independently of the retort benches.

The main coal-handling equipment is at the coke-plant end of the retort house, and here the lip-bucket conveyor is duplicated. A single line of conveyors at the railway end of the retort house serves as an auxiliary or a stand-by. Coal from the lip-bucket conveyors passes to either of two 42-in. flat band conveyors which deliver it to the bunkers over the retorts. These bunkers have a capacity equal to 48 hours' supply for the retorts. The duplicate flat band conveyors are reversible, to receive coal from either end of the house, and each has four travelling ploughs, two facing each direction of travel, which can be lowered and raised as required. One line is shown in Fig. 1.

COKE HANDLING

Coke is discharged from the retorts by vertical helical-type extractors driven through masked ratchets and worm gear by reciprocating bars. The drive is by electric motor, with a vertical steam engine as a stand-by. Independent sets of extractor driving gear are provided at both ends of the house, and either can be used to drive the whole plant, or alternatively each can drive half.

The coke passes through a travelling chute to either of two 36-in. band conveyors, which are reversible so that they can deliver to either end of the house. At the coke-plant end the coke is elevated by one or other of the two lip-bucket conveyors and delivered to one of two 30-in. troughed band conveyors which cross the yard to the coke-grading plant above the storage bunkers. Alternatively, the coke can be delivered to the producer and retort-feed hoppers at each end of the house. At the railway end of the house the coke is elevated by the single lip-bucket conveyor into a 175-ton storage hopper, or to producer or retort-feed as required. From the 175-ton hopper coke can be discharged into road vehicles, or it can be reclaimed to either of the conveyors passing below the retort benches and taken to the grading plant.

COKE GRADING

Coke from the overhead band conveyors can pass to a West-Calvert coke-cutter, or direct to the screens. The coke-cutter, which is of the single-roll type, is capable of reducing 35 to 40 tons of coke per hour to 2-in. cube. The screens are in two parallel lines, one of the Pegson-Telsmith vibrating type and the other of West's selective (band) conveyor type. These are both shown in Fig. 3, opposite. The Pegson-Telsmith line has a primary screen with 2-in. mesh, a second with 1¼-in. mesh, a third with ¾-in. mesh, and a fourth, for breeze, with ⅜-in. mesh. The screens are interconnected by band conveyors. The West's screen is a normal flat band conveyor with screening units mounted above the band at an angle across the line of travel. The screening units are on the comb principle, with steel rod fingers faced with a chromium deposit and welded to a steel supporting bar. The units are supported in flexible steel shock-absorbers, and vibrated electrically at high frequency and small amplitude. The spacing of the combs is similar to the meshing of the Pegson screens.

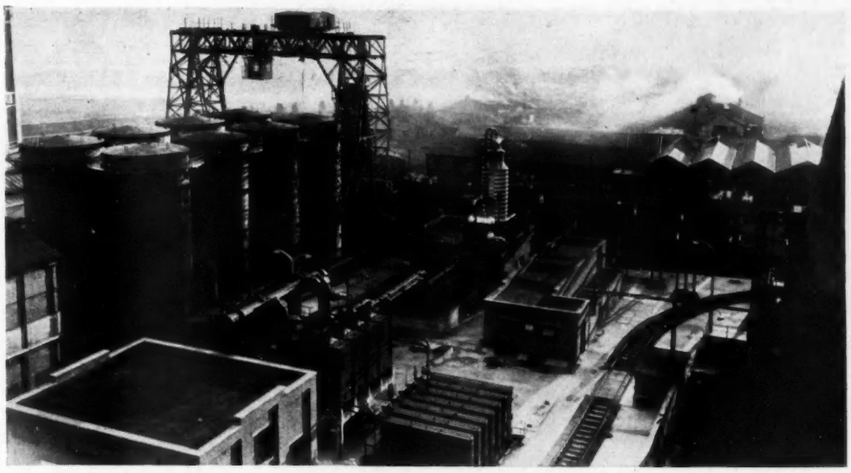


Fig. 4 Dry purification is by the Holmes tower purifiers seen on the left. In the centre rear is the benzole oil-stripping unit and in the centre front the benzole washers and rack coolers.

Screened coke passes to storage bunkers below the screening plant, the bunkers having a capacity of 700 tons. They are divided into five compartments, for coke over 2 in., through 2 in. and over 1¼ in., through 1¼ in. and over ¾ in., through ¾ in. and over ⅜ in., and breeze, through ⅜ in. Seven outlet chutes, each with a Pegson fixed de-breezing screen, are provided on one side of the plant for filling railway wagons. On the other side there is a bag-filling platform with seven outlet chutes leading to a travelling de-breezing screen and a travelling Avery automatic weighing and bag-filling machine.

Coke for producer-feed and for filling retorts after scurfing is stored at both ends of the retort house. Pegson de-breezing screens are fitted to the outlets for producer coke. A producer-feed runway extends the full length of the producer house, and carries two electrically-propelled skips. An Avery automatic weigher and totaliser is installed to record the weight of the coke in the skips. All fuel consumed is thus recorded. A retort-feed runway with two skips is installed along the full length of the retort house for charging the retorts after scurfing.

Clinker from the producers is fed manually to a 24-in. band conveyor discharging to a skip hoist at the railway end of the retort house. A runway and skip for hand-operation is provided as a stand-by. The ash-storage hopper is of 36 tons capacity, with outlets to road vehicles.

ELECTRICAL EQUIPMENT

All the plant, with the exception of the waste-heat boiler fans and feed-water pumps, is electrically-driven. The motors, which are all of Lancashire Dynamo and Crypto manufacture, are designed for a three-phase, 50-cycle, alternating-current supply at 415 volts. The starters for the motors on the coal and coke handling plants are mounted on a composite control panel which is shown in Fig. 2 opposite and is housed in an annexe to the retort house. The control panel is complete with all necessary interlocks and switches for correct sequence starting and stopping. Coloured strips and lights on the master control panel indicate which units are in operation. For safety purposes push-button stops are provided adjacent to each motor and at numerous other points in the run of each conveyor; over seventy emergency stop points are installed. The plant is lighted throughout by dust-proof, totally-enclosed electric lamps, with or without dispersive reflectors according to situation.

Power is generated by two Belliss and Morcom/Metropolitan-Vickers turbo-alternators, shown in Fig. 5, generating at 6,000 volts and feeding bus-bars at one end of an E.H.T. switchboard and then, through two 750-kVA transformers, to a 415-volt switchboard. At the opposite end of the E.H.T. switchboard a supply is taken from either of two feeders provided by the Midlands Electricity Board. Two more 750-kVA transformers and a separate section of the 415-volt switchboard deal with the current from this source. Provision has been made for parallel operation of the turbo-alternators with the M.E.B. supply. Supplies are taken from the 415-volt switchboard to the several distribution switchboards at various points in the plant.

PURIFICATION

There are three Holmes primary condensers of conventional vertical-tube design, erected overhead on a reinforced-concrete structure and arranged to work in parallel. Each has a normal capacity of 5 million cub. ft. per day and is capable of reducing the gas from 175 deg. F. (saturated) to within 5 deg. F. of the cooling-water temperature. They are arranged for a dual water supply, the hot end being supplied with water from a natural-draught cooling tower, and the cold end, when required, from a separate supply at a much lower temperature.

Three Holmes-Elex electrical de-tarrers are arranged on the same structure as the primary condensers; each is capable of handling 5 million cub. ft. of gas per day, measured at standard temperature and pressure but in the hot saturated condition. The condenser and de-tarrer plant is arranged for great variation in working conditions, and it is possible to operate the system on hot gas de-tarring only, cold gas de-tarring only, or with two units on hot de-tarring followed by one on cold gas.

EXHAUSTERS

Two high-speed Holmes Connersville exhausters have been installed, each one being driven by a 110-h.p. Belliss and Morcom vertical, two-crank, non-compound steam engine. Each exhauster is of the Roots positive-displacement type, and is rated at 12·9 million cub. ft. of gas per day. They can work against an outlet pressure of 48 in. w.g., while maintaining a

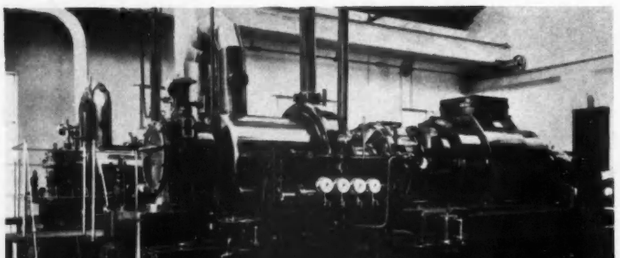


Fig. 5 Power generation is by two Belliss and Morcom / Metropolitan-Vickers 1,000-kW turbo-alternators.

vacuum of 6 in. w.g., when running at 366 r.p.m. with a power consumption of 98 h.p. Vacuum control is maintained by the normal hydraulic regulator and equilibrium steam throttle valve in the steam supply line varying the speed of the engine. A cubicle-type instrument panel by the Electroflo Meters Company is installed in the exhauster house. It has 8 water-gauges, a vacuum and pressure recorder, live and exhaust steam pressure gauges and an indicating thermometer.

TAR AND LIQUOR ARRANGEMENTS

The main storage well is divided into four compartments for the reception of: works liquor for disposal; the liquor from retort house circulation and hot gas de-tarrers; tar from retort house and de-tarrers; light creosote oil separated from the gas following the hot gas de-tarrers. There are two separators at ground level under the de-tarrers and condensers, one for dealing with tar and liquor and the other for separating light creosote oil from its associated liquor. There is an auxiliary separator seal pot at the ammonia washers and a further separator deals with condensate from purifiers and gas main syphons.

The liquor, tar and creosote lines are provided with valves so that the products can be directed to the appropriate compartments in the well, dependent upon whether de-tarring is operating on hot or cold gas. Liquor and light creosote from the main separators flow by gravity to the main storage wells, but tar flows first to a 10,000 gallon reception tank, from which it can flow by gravity or be pumped to the tar well by a Lee-Howl reciprocating pump with flameproof electric drive. A variable thermostat-controlled cooler is provided for the retort house circulating liquor. Ammonia is removed by two Holmes static multifilm washers, connected in parallel.

DRY PURIFICATION

A set of Holmes tower purifiers is installed to deal with a maximum flow in one stream of 10 million cub. ft. per day. There are six working towers each 22 ft. 3 in. diameter by 52 ft. 9 in. high; each tower holds twelve double-layer containers of octagonal form with timber grids. The towers are arranged with a bottom chamber into which the gas enters and flows up the continuous gas-way formed by the individual gas-ways in each container. Provision is made for backward rotation working of the towers. A stocking tower and stocking frame of similar dimensions to the working towers are included, together with a spare set of containers to be kept filled with fresh oxide for quick changing of a tower. A 60-ton Stothert and Pitt Goliath crane of 64 ft. span, with a speed of 17 ft. per minute on the main lift, runs over the purifier set, and with its aid any tower can be emptied and re-filled in one working day. Access to the top working platform is provided by a Wadsworth lift. Two Connersville blowers driven by two-speed flameproof motors enable revivification air to be introduced into any tower. A purging machine of 15,000 cub. ft. per hour capacity, with suitable connections, is built into the plant for routine purging of any tower before opening it for changing oxide. The towers can be seen in Fig. 4.

An oxide store shed, 55 ft. by 66 ft., at one end of the site is arranged for the stocking of fresh oxide on an upper floor and the working of spent oxide on the ground floor. Spent oxide can be handled at 20 tons per hour.

BENZOLE RECOVERY

The Holmes benzole recovery plant installed is designed to extract 85 per cent. of the available benzole from the gas. Two static multifilm washers of the countercurrent type are provided for washing the gas from the new retort house. Benzolized oil from these washers and from other washers is stripped by vacuum-distillation. The new washers have a capacity of 10 million cub. ft. per day and the oil-stripping section, having an hourly oil circulation design rate of 8,500 gallons per hour, is planned to handle oil from washers having a total capacity of 20 million cub. ft. of gas per day. They can be seen in Fig. 4.

In the oil-stripping section of the plant benzolized oil from the washers is first partially heated in a heat-exchanger by steam and benzole vapours leaving the still, and after being further heated by hot oil leaving the still and by exhaust steam, the rich oil passes to the top tray of the still. It passes down the twelve trays of the still (which is of the bubble-cap type) where it is stripped of its benzole by an ascending current of exhaust steam. Pressure in the still is approximately 10 in. mercury absolute. The hot stripped oil is pumped from the base of the still through oil-to-oil heat-exchangers, and is finally cooled in a bank of rack coolers from which the oil goes to the gas-outlet bays of the various washers. Vapours leaving the vapour-to-oil heat-exchanger are condensed and the resulting mixture of benzole and water is discharged by the vacuum pump to a separating vessel.

ANCILLARIES

Two Holmes Connersville 26-in. by 66-in. positive-displacement type station meters are provided. Each has a normal rated capacity of 450,000 cub. ft. of gas per hour, and is suited to the measurement of purified gas up to a maximum pressure of 48 in. w.g. The meters have counters reading in cub. ft., and pressure, volume, temperature and time recorders.

For pumping gas from the 5-million cub. ft. waterless gasholder through a 20-in. diameter high-pressure main and governors to the low-pressure distribution system, there are two Waller gas compressors. They are of the vertical, two-crank, reciprocating type, each having a capacity of 400,000 cub. ft. of gas per hour at 15 lb. per square inch pressure. The compressors are driven by Laurence Scott and Electromotors variable-speed motors of 496 h.p.

Instrumentation has been kept to a minimum consistent with efficient control. The instruments, which are generally of the indicating and recording type, are either mounted locally where they can be observed as adjustments are made, or grouped for remote control. The calorific value of the purified gas is recorded on a Fairweather recording calorimeter.

AMENITIES

Working conditions are particularly good. Two British Vacuum Cleaner vacuum cleaning plants are provided in the retort house and one in the coke-grading plant. They are equipped with exhausters of the fan-turbine type, electrically driven, and capable of dealing with 250 cub. ft. of air per minute. The extracted air is passed through a filter before discharge to atmosphere. Air lines are arranged along the walls with quick-acting connections for brushes and other collecting tools. Mess-rooms, sanitary equipment and showers are provided in an annexe to the retort house for the use of the stokers.

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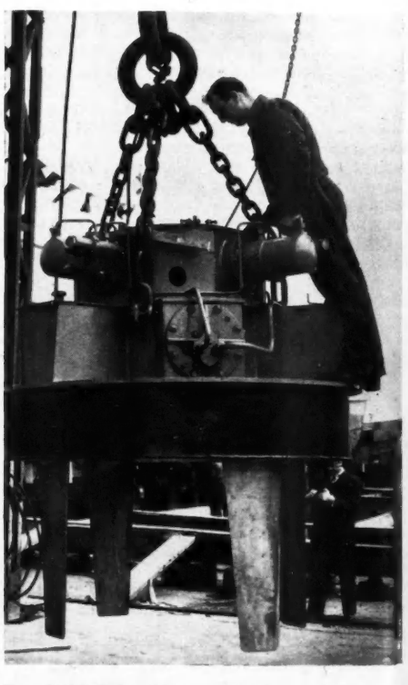
LAUNCH OF TANKER "B.P. HAULIER"

Voith-Schneider Propeller to Give Enhanced Manoeuvrability

The first of a fleet of nine tankers to be operated by Shell-Mex and B.P., Limited, in the estuaries around Britain was launched on Friday, April 22, at the Faversham shipyard of James Pollock, Sons and Company, Limited. The new vessel, "B.P. Haulier," which is of 300 tons cargo-carrying capacity, is believed to be the first tanker to employ a Voith-Schneider propeller-steering unit, and will sail between refineries on the Medway and Thames estuaries and the petroleum company's depot at Faversham.

The Voith-Schneider principle, which was described in ENGINEERING in 1939 (vol. 148, page 315), is specially suitable for vessels operating on narrow and tortuous waterways, and serves both for propulsion and steering. As can be seen in the accompanying illustation, the unit embodies a number of vertical blades;



The Voith-Schneider combined propeller and steering mechanism employed in the "B.P. Haulier" offers improved manoeuvrability for the negotiation of constricted waterways.

these project downward into the water and are carried by a hub set into the hull of the ship. The hub revolves in a horizontal plane and the blades are feathered to give a thrust in any direction required. In the version used for the tanker, provision is made so that in reversing from forward motion to astern, the blades pass through a neutral position and do not impart any intermediate sideways thrust.

The propulsion plant of the B.P. Haulier will consist of a Lister-Blackstone EVMC6 oil engine rated at 270 brake horse-power when running at 600 r.p.m., and will transmit torque through an oil-operated isolating clutch to the Voith-Schneider propeller. The main crankshaft will be extended at the forward end to drive, through a friction clutch and V-belts, two Stothert and Pitt screw-displacement cargo pumps situated at deck level forward of the machinery compartment. All the V-belts are of special composition, with anti-static characteristics, and are therefore suitable for use in the presence of petroleum vapour.

The engine room will also be fitted with two auxiliary sets, each to be driven by a Lister 2JPMA engine rated at 18 brake horse-power at 1,000 r.p.m. One engine will drive a flameproof Lancashire Dynamo and Crypto 10-kW 110-volt direct-current generator. The other set will incorporate a similar generator, which will drive, through clutches, a Hamworthy two-stage 2SM3 compressor, delivering 12¼ cub. ft. free air per minute at 350 lb. per square inch, for starting the main engine. It will also drive a Hamworthy centrifugal automatic self-priming pump, size D2, having an output of 30 tons an hour, for general-service duties. All these engines will be provided with flame-trap air intakes, and all engine apertures will be fitted with flameproof gauzes to give full protection in the vicinity of petroleum gases.

The hull, which has an overall length of 148 ft. and a beam of 27 ft. 6 in., is double skinned and designed to meet Port of London Authority and Lloyds requirements for the carriage of petroleum on the Thames. To facilitate control of the ship in difficult river conditions the bridge amidships provides a clear view forward and aft.

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INTERCOMMUNICATION UNIT FOR SIDE-CARS

A disadvantage of family motor cycling has been the virtual impossibility of conversation between the rider and the side-car passenger. To overcome this, Pye Limited, P.O. Box 49, Cambridge, have developed an intercommunication set which can be fitted to Watsonian side-cars. A headphone inside the rider's helmet is connected to a unit consisting of a loudspeaker and a two-valve amplifier mounted in the side-car. The microphones are designed to cut out engine noise. The lead from the helmet plugs into the side car and will pull out if the rider does not disconnect before he dismounts.

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LIGHTWEIGHT FLEXIBLE HOSE

To meet the requirements of the oil industry, a lightweight rough-bore flexible hose has been produced by the Compoflex Company, Limited, 26 Grosvenor-gardens, London, S.W.1. Known as the "Featherweight," it can be used for either suction or delivery of water, oil, petrol, benzole or other chemicals. Sizes vary from 1½ in. inside diameter (weighing 0·65 lb. per foot) to 4 in. o.d. (weighing 2·9 lb. per foot). Bends of 2½ in. and 8 in. radius can be made respectively with the two sizes. The hose is made up of an inner exposed wire helix with a fabric liner coated with "Molene," a special polyvinyl chloride mixture. This can be varied to handle special liquids. Over this layer is a canvas cover, also coated with Molene, and then an outside steel-wire helix. All the layers are bonded together by a steam-curing process which enables the hose to be used at 200 deg. F. continuously.

Labour Notes

RAILWAY STRIKE AVERTED

An agreement reached last Saturday afternoon resulted in averting the intended strike of some 60,000 British Railways footplate men at midnight on Sunday. Instead, there was an informal meeting between the British Transport Commission and officials of the Associated Society of Locomotive Engineers and Firemen on Monday to consider the union's demand for a larger difference between the wages of the locomotive men and those of other railway employees.

This discussion was held as a preliminary to further negotiations on the union's demands, in which it had been agreed, by both the Commission and the A.S.L.E.F., that representatives of the National Union of Railwaymen should take part.

Although the strike was called off, the basic dispute which gave rise to the threatened action has thus remained. It was part of the settlement by which the footplate men were instructed by the A.S.L.E.F. to "continue at work" that the Commission should use every endeavour to reach agreement at these further discussions. The Commission also announced its intention that these discussions should be concluded at the earliest possible date.

There appears to be no reason for considering that the A.S.L.E.F. has in any way abated its determination to maintain the differential, whereby the skill and responsibility of the footplate men is recognised by the receipt of higher wages than those paid to other grades of railwaymen. The National Union of Railwaymen, on the other hand, may well seek to secure for railway conciliation staffs an equivalent of any further pay concessions granted to the locomotive men, but an encouraging feature of this apparently intractable problem is that many footplate men are members of the N.U.R.

PART PLAYED BY THE T.U.C.

As recently as the night of April 28, the prospects of reaching any form of agreement between the Commission and the A.S.L.E.F. seemed very slight indeed and there appeared to be little prospect of any further direct conciliation efforts on the part of officials of the Ministry of Labour.

The moves which eventually led to an easing of the situation are thought to have begun on Friday, when Sir Walter Monckton, the Minister of Labour, met leading officials of the Trades Union Congress. They, in turn, had a meeting first with the representatives of the A.S.L.E.F. and then with the Commission.

On Saturday, there was a further meeting between T.U.C. officials and members of the union. What attitude the T.U.C. officials adopted has not yet been made known but they clearly succeeded in persuading the union to assume a more conciliatory attitude, especially in regard to the vital problem of the admission of delegates of the N.U.R. to the new discussions.

It appears that these negotiations will re-open, for the third time since 1953, the whole question of railway-wage rates.

DEATH OF MR. A. DEAKIN

Mr. Arthur Deakin, general secretary of the Transport and General Workers' Union since 1945, died on Sunday night in Leicester Royal Infirmary. He had collapsed a short time previously while addressing a May Day rally at the Corn Exchange, Leicester.

Mr. Deakin, who was 64 years of age, had taken a prominent part in discussions at the end of last week between the T.U.C., the British Transport Commission and the A.S.L.E.F., which resulted in the calling off of the threatened strike of the railway footplate men. As recently as last Saturday, he had acted as chairman of the general purposes committee of the T.U.C. at their meeting with the executive committee of the A.S.L.E.F.

He was born on November 11, 1890, at Sutton Coldfield, Warwickshire, and his father, a cobbler, died during Arthur's early childhood. At the age of 13, he obtained a job for a few shillings a week at the Dowlais works of Guest, Keen and Nettlefolds, Limited.

During the period of the 1914-18 war, he took an increasingly important part in the affairs of his trade union and, in 1919, was appointed a paid whole-time official of the Dock, Wharf, Riverside and General Workers' Union, in Flintshire, and continued to occupy that position when the union amalgamated with others to form the Transport and General Workers' Union.

In 1932, he came to London as national secretary of the union's general workers' group, where his administrative abilities came to the attention of Mr. Ernest Bevin, then the union's general secretary. He became Mr. Bevin's assistant in 1935 and later succeeded him in the higher position.

For his services to his country, he was appointed a member of the Privy Council last year, having previously received the C.B.E. in 1943, and the C.H. in 1949.

INCREASED PAY FOR SEAFARERS

Wage increases of about 7½ per cent. for officers and men of the British mercantile marine were announced by the National Maritime Board on April 26 and are due to come into force on May 30.

These increases will apply to adult ratings and to navigating, engineering and radio officers, but higher rates, ranging up to as much as 12 per cent., will be payable to chief officers on foreign-going vessels and to second engineers with certificates. The Board's announcement emphasised that "the position of shipmasters in relation to the percentage increase for officers has been ensured."

A feature of the new agreement as it applies to officers is that contributions to the merchant navy officers' pension fund, which has hitherto been 3¾ per cent. of basic salary for the officer and a like amount from the shipowners, has been increased to the equivalent of 5 per cent. of officers' basic salary from both sides.

In future, able seamen and efficient deck hands will be paid £27 10*s*. a month to commence, with food and accommodation provided by the owners, and will be entitled to four annual increments, leading to a maximum basic wage of £31 10*s*. a month, with all found. Firemen will start at £28 a month and assistant stewards at £26 10*s*.

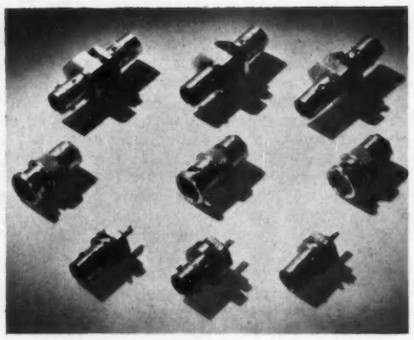
WORKING CONDITIONS IN THE PETROLEUM INDUSTRY

The pay and working conditions of employees under contract in the petroleum industry, and means for the improvement of human relations in the industry, were among the subjects due to be discussed at the fifth session of the Petroleum Committee of the International Labour Organisation, at Caracas, Venezuela, which opened on April 25 and will continue until to-morrow.

The general report of the International Labour Organisation was also discussed. This document deals specifically with the action taken in various countries in respect of recommendations adopted at previous sessions of the Petroleum Committee, steps taken by the International Labour Office to follow up the studies and inquiries proposed by the Committee, and recent events and developments in the industry. The advantages of visual aids for training purposes were also examined.

Sir Guildhaume Myrddin-Evans, K.C.M.G., deputy secretary of the Ministry of Labour, and representative of the United Kingdom Government on the governing body of the International Labour Office, attended the meeting of the Committee as its chairman and as representative of the governing body. There were also present other representatives of the United Kingdom Government and of employers' organisations in the United Kingdom, but no delegates representing workpeople in this country attended.

The previous session of the Committee, held in Scheveningen, Holland, in October, 1952, was attended by representatives from 14 countries.



The three types of connector in the illustration are: top row, bulkhead-mounted connectors; middle row, cable connectors; bottom row, panel-mounted connectors.

CABLE CONNECTORS FOR ELECTRONIC EQUIPMENT

Vibration-Proof Lock

New positive-locking connectors for use in electronic airborne and ground equipment are now being marketed by Smiths Aircraft Instruments, Limited, Cricklewood, London, N.W.2. With these units connection and disconnection of coaxial and single-core cable is a single-handed operation which can be achieved even with the connectors in awkward locations. The positive-locking action ensures a vibration-proof connection at all times.

The connectors can be deliberately rendered non interchangeable by transposing the male and female contacts and using long-throw bayonets. This ensures that cross connections cannot be made in a group of up to three connectors.

Three basic types of connectors are available: cable-mounted, panel-mounted, or bulkhead-mounted. Cable-mounted connectors are made to suit either Uniradio 32 or 70 coaxial cables, P.T.F.E. (0·15 in. outer diameter) or Uniradio 72 coaxial cable or Unipren 6. Connectors for other cables with a slightly different outside diameter can be supplied as a special requirement.

Panel mounted connectors have been designed for mounting on a case or a panel where external quick release or connection is required. They are available in a sealed or unsealed form. The sealed version, capable of withstanding pressure differences of up to 30 lb. per square inch can have either male or female contacts.

The bulkhead-mounted connectors are suitable for fitting to pressure bulkheads through which cable has to pass and where quick connection or disconnection is required on each side of the bulkhead. All these connectors are sealed axially by a glass seal and incorporate an annular sealing ring between the flange and bulkhead. Like the sealed panel-mounted connectors, the bulkhead connectors will withstand pressure differences up to 30 lb. per square inch.

All three connectors are silver-plated and will operate satisfactorily at temperatures of 250 deg. C. The P.T.F.E. (polytetrafluorethylene) insulator is shaped to provide a long narrow leakage path. The voltage standing wave ratio is less than 1·35 to 1 in a 50-ohm system; the maximum voltage is 500 volts, and the current-carrying capacity is 1 amp. All connectors are interchangeable with their equivalent B.N.C. types of American manufacture.

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N.P.L. OPEN DAY

The National Physical Laboratory at Teddington is holding an open day on Friday, May 20. Admission is by ticket only and a few are still available for the afternoon period 1.30 p.m. to 5.30 p.m. Application should be made to the Director.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Electrical Instruments," by G. E. Edwards. Central London Branch. St. Ermin's Hotel, Caxton-street, S.W.1. Mon., May 9, 7 p.m.

BIRMINGHAM
Film Evening. Birmingham Branch. Birmingham Chamber of Commerce, 95 New-street, Birmingham. Wed., May 11, 7.15 p.m.

HALIFAX
"Aims and Objects of the Association," by L. L. Emmett. Bradford Branch. Crown Hotel, Horton-street, Halifax. Wed., May 11, 7.30 p.m.

British Institution of Radio Engineers

LONDON
"The Development of the Underwater Television Camera," by D. R. Coleman, D. A. Allanson and B. A. Horlock. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., May 18, 6.30 p.m.

Chemical Society

LEEDS
Symposium on "Friedel-Crafts Reaction." Leeds Branch. Department of Chemistry, The University, Leeds. Wed., May 18, 10 a.m. and 2.15 p.m.

NEWCASTLE-UPON-TYNE
Centenary Lecture on "Chemical Effects of Steric Strains," by Professor H. C. Brown. Newcastle and Durham Branch. Chemistry Building, King's College, Newcastle-upon-Tyne. Fri., May 13, 5.30 p.m.

Illuminating Engineering Society

LONDON
Annual General Meeting. "Illuminated Chateaux of France," by J. J. Chappat. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 10, 6 p.m.

Incorporated Plant Engineers

CARDIFF
Various short talks by members of the branch. South Wales Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., May 17, 7.15 p.m.

GLASGOW
"The Human Factor and Productivity," by Mrs. T. M. Ritchie. Glasgow Branch. Scottish Building Centre, 425 Sauchiehall-street, Glasgow. Wed., May 11, 7 p.m.

MANCHESTER
"Notes on the Statutory Requirements of Steam and Pressure Vessels and Machinery," by W. H. Mills. Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., May 10, 7.15 p.m.

NEWCASTLE-UPON-TYNE
Films on "Excavators," introduced by I. S. Writeman. North-East Branch. Roadway House, Oxford-street, Newcastle-upon-Tyne. Thurs., May 12, 7 p.m.

NOTTINGHAM
Film Evening. East Midlands Branch. County Hotel, Nottingham. Wed., May 11, 7 p.m.

Institute of British Foundrymen

COVENTRY
"Some Aspects on Cupola Operation," by W. H. Bamford. Coventry Section. Coventry Technical College, Coventry. Tues., May 10, 7.30 p.m.

Institute of Marine Engineers

LONDON
Symposium on "Advanced Machinery Installations Designed for the Maximum Saving in Weight and Space." Joint Meeting with the Institution of Naval Architects. Tues., May 10, 5.30 p.m.

Institute of Petroleum

LONDON
"Evaporation Losses from Petroleum Storage Tanks in the United Kingdom," by E. H. Walker, R. M. Eltringham and A. Puttick. Wed., May 11, 5.30 p.m.

Institute of Road Transport Engineers

CARDIFF
"Paint Synthetic Resin Finishes and Wet-on-Wet Spraying," by C. Butler. South Wales Group. South Wales Institute of Engineers, Park-place, Cardiff. Thurs., May 12, 7 p.m.

Institute of Welding

BIRMINGHAM
Annual General Meeting and Open Discussion on "Welding Problems." Birmingham Branch. Birmingham and Midland Institute, Paradise-street, Birmingham, 1. Fri., May 20, 7.30 p.m.

Institution of Civil Engineers

LONDON
"Some Notes on the Half-Through Type Plate Girder Railway Bridge," by P. S. A. Berridge and F. M. Easton. Railway Engineering Division. Tues., May 10, 5.30 p.m.
"Some Steel Structural Frames Designed on Plastic Theory," by D. H. Little and A. Augustus Smith. Structural and Building Engineering Division. Thurs., May 12, 5.30 p.m.
"Working Capacity of Roads," by A. J. H. Clayton. Road Engineering Division. Tues., May 17, 5.30 p.m.

BIRMINGHAM
Annual General Meeting. Midlands Association. James Watt Memorial Institute, Great Charles-street, Birmingham. Thurs., May 12, 6 p.m.

Institution of Electrical Engineers

LONDON
Symposium on "Transistors and other Semi-Conductor Devices": including "Junction Transistor Noise in the Frequency Range 7 to 50 Kc/s," by W. L. Stephenson; and "Noise in Silicon Microwave Diodes," by G. R. Nicoll. Radio Section. Wed., May 11, 5.30 p.m.
Discussion on "Image Intensification in Radiology," opened by Dr. W. J. Oosterkamp and Dr. G. M. Ardran. Thurs., May 12, 5.30 p.m.
Address on "The Effect of Atomic Energy on the Generation of Power," by the President of the Institution, Mr. J. Eccles. Annual General Meeting and Film Evening. London Students' Section. Mon., May 16, 6.30 p.m.
Questions Night. Education Discussion Circle. Tues., May 17, 6. p.m.
"The Supply of Electricity in the London Area," by D. B. Irving. Supply Section. Wed., May 18, 5.30 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
Annual General Meeting. North-East Branch. Crown Hotel, Clayton-street, Newcastle-upon-Tyne. Fri., May 13, 6.15 p.m.

Institution of Mechanical Engineers

LONDON
"An Investigation of Hydraulic Lock," by J. Manhajm and Dr. D. C. Sweeney. Hydraulics Group. Fri., May 13, 5.30 p.m.
Annual General Meeting. "Servo Control," by P. J. Bhatt. London Graduates' Section. Wed., May 18, 6.30 p.m.

BIRMINGHAM
Annual General Meeting and Chairman's Address. Midland Graduates' Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., May 16, 6.45 p.m.

Institution of Naval Architects

LONDON
Symposium on "Advanced Machinery Installations Designed for the Maximum Saving in Weight and Space." Joint Meeting with the Institute of Marine Engineers. 85 The Minories, E.C.3. Tues., May 10, 5.30 p.m.

London Association of Engineers

LONDON
Film Evening. Salisbury Square House, Salisbury-court, Fleet-street, E.C.4. Sat., May 7, 6.30 p.m.

Royal Aeronautical Society

LONDON
43rd Wilbur Wright Lecture: "Flight Control," by Dr. C. S. Draper. Royal Institution, 21 Albemarle-street, W.1. Thurs., May 19, 6 p.m.

Royal Institution

LONDON
"The No-Man's Land Between Conductors and Insulators," by R. W. Douglas. Fri., May 13, 9 p.m.

The Royal Society

LONDON
Film on "Some Research Activities of the Istituto Superiore di Sanità, Rome," with an introductory address by the director-general, Professor D. Marotta; and "Some Recent Advances in Carbohydrate Metabolism," by E. B. Chain. Thurs., May 12, 4.30 p.m.

Royal Society of Arts

LONDON
"The Planning of Roads," by E. W. H. Vallis. Wed., May 11, 2.30 p.m.
"Scientific Research in India," by Professor Sir Alfred Egerton. Thomas Holland Memorial Lecture. Commonwealth Section. Thurs., May 19, 5.15 p.m.

Society of Instrument Technology

LONDON
Annual General Meeting and Presidential Address. Manson House, 26 Portland-place, W.1. Tues., May 24, 6 p.m.

Women's Engineering Society

LONDON
"Heavy Civil-Engineering Works," by C. K. Haswell. London Branch. Hope House, Great Smith-street, S.W.1. Thurs., May 12, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Civil Engineers, Great George-street, London S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland place, London, W.1. (LANgham 8847.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
London Association of Engineers, 5 Wimborne-grove, Watford, Hertfordshire. (Watford 6044.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (POLlards 3620.)
Women's Engineering Society, 45 Eastcastle-street, London, W.1. (LANgham 9571.)